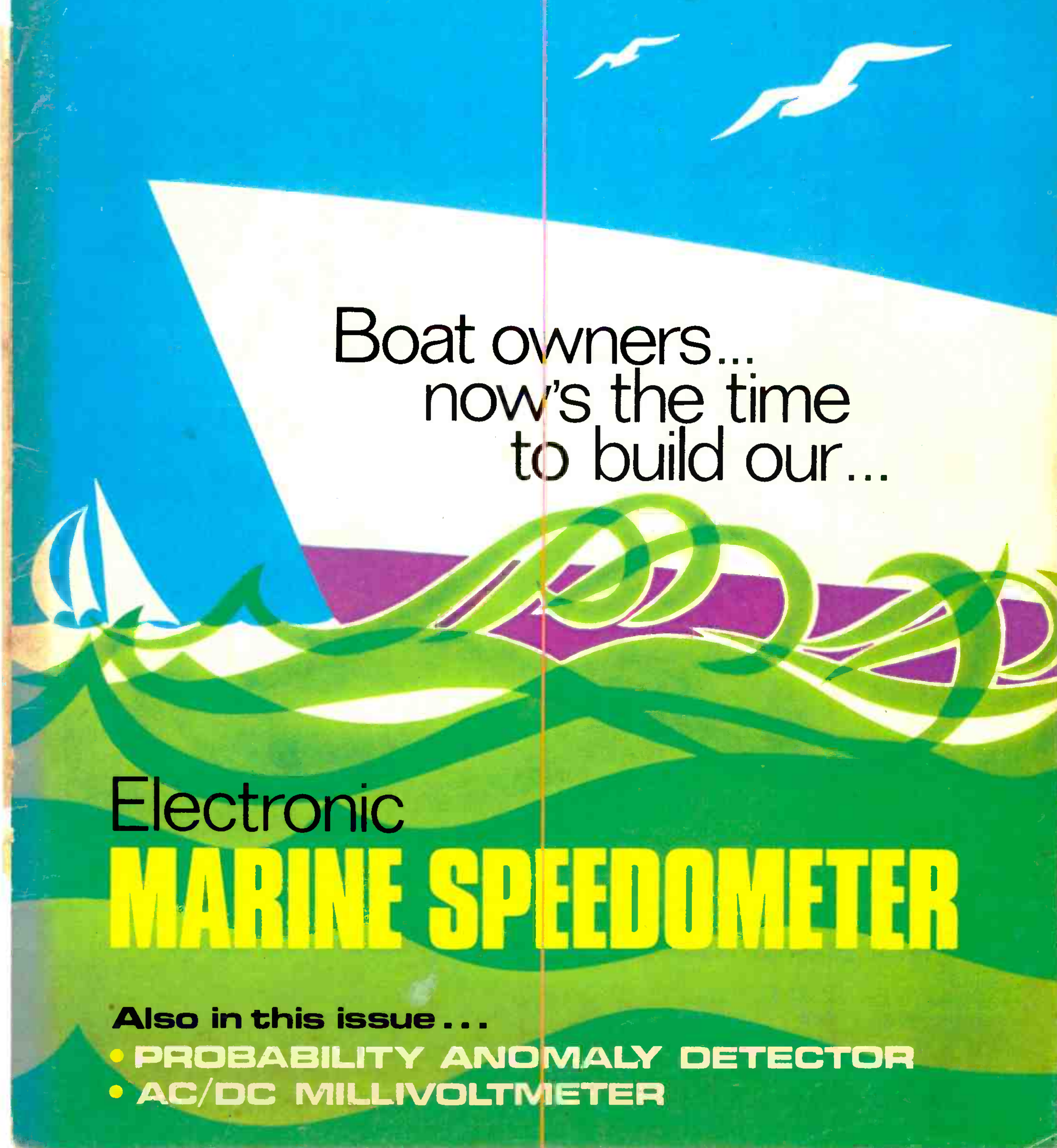
PRACTICAL
ELECTRONICS

FEBRUARY 1975 25p



PRACTICAL
ELECTRONICS

VOLUME 11 No. 2 FEBRUARY 1975

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

Our March issue will be published on Friday, February 14, 1975

ERSIN

Multicore

5 CORE SOLDER

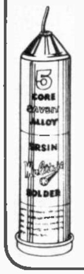
for fast easy reliable soldering

EASY TO USE DISPENSERS AND REELS

IDEAL FOR HOME CONSTRUCTORS

Ersin Multicore Solder contains 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux is required.

SAVBIT handy solder dispenser



A coil of Ersin Multicore Savbit Solder in a dispenser 7ft 6 in of 18 s.w.g. (2.2 metres of 1.22mm). The Solder that reduces the wear of soldering iron bits.

Size 5 32p

SAVBIT solder for general purpose work

A handy plastic reel of SAVBIT alloy. 63ft of 18 s.w.g. (19.2 metres of 1.22mm)

Size 12 £1.72

ALU-SOL for soldering aluminium

New Multicore Alu-sol flux-cored solder in 16 s.w.g. No extra flux needed. Plastic reel holds 36ft. Supplied with full instructions. Also available in solder dispenser.

Size 4 £2.32

Fine gauge solder for soldering small components

Fine gauge solder for soldering small components 138ft of 22 s.w.g. (42.0 metres of 0.71mm) Ersin Multicore 5 core solder wound on a plastic reel. Suitable for intricate work and small components.

Size 10 £1.44

For soldering fine joints

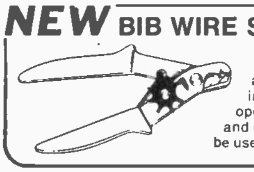
Dispensers of Ersin Multicore Solder make those small jobs easier. 21ft of 22 s.w.g. (6.4 metres of 0.71mm) solder, specially suitable for soldering fine wires, small components and for repairing printed circuits.

Size 15 36p

Or size 19A for kit wiring or Radio and T.V. repairs 7ft. (2.1 metres) of 18 s.w.g. (1.22mm) Ersin Multicore Solder.

Size 19A 34p

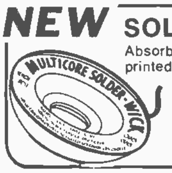
NEW BIB WIRE STRIPPER & CUTTER



Fitted with unique 8 gauge selector with handle locking device and easy grip handles. Spring incorporated for automatic opening. Strips insulation from flex and cables in seconds and can also be used as a cutter.

Model 8B. 70p

NEW SOLDER WICK



Absorbs solder instantly, from tags and printed circuits. Only needs 40 to 50 Watt soldering iron. Quick and easy to use. Does not need flux and is non-corrosive.

Size 18 90p

Bib Hi-Fi Accessories Limited,
Sole U.K. Sales Concessionaires, P.O. Box 78 Hemel Hempstead, Herts. HP2 7EP

Prices shown are recommended retail excluding V.A.T.
From Electrical and Hardware Shops. If unobtainable, send 15p P&P.
Prices and specifications subject to change without notice.

P. F. RALFE

10 CHAPEL ST. LONDON NW1 Phone 01-723 8753

MUFFIN INSTRUMENT FANS
Dimensions 4·5in × 4·5in × 1·5in. Very quiet running, precision fan specially designed for cooling electronic equipment, amplifiers, etc. For 110V, a.c. operation (practice is to run from split primary of mains transformer or use suitable mains dropper). CC only 11 watts. List price over £10 each. Our price, in brand new condition, is £3·50.

MINIATURE SOLENOIDS
12–24V 140Ω. Coil size 1½in × ½in × ½in. All brand new. Price **65p**.

McMURDO 6-WAY EDGE CONNECTORS, PLUGS & SOCKETS
C/W Covers. Brand new. Quantities are available at only **25p** each.

DURATRAK VARIACS
Type 100L. 230V input. 0–230V a.c. output. 8 amps. Brand new minus control knobs. Price only **£15**, carriage £1.

AERIAL CHANGE-OVER RELAYS
of current manufacture designed especially for mobile equipments, coil voltage 12V, frequency up to 250MHz at 50 watts. Small size only, 2in × ½in. Offered brand new, boxed. Price **£1·50**, Inc. P. & P.

TV WOBBULATOR Type '210'
Technical characteristics
Frequency: 5 to 220Mc/s in one range.
Accuracy: That of the marker generator (e.g. METRIX 936).
Output: Not less than 100mV attenuable in steps of 10 down to 10μV.
Sweep width: 1–2–5–10–20Mc/s.
Linearity: 10% at sweep width 10Mc/s.
Amplitude modulation: Less than 10% at sweep width 10Mc/s.
Power supply: 110–130–220V, 50–60c/s. 130V may be replaced by 160V, 220V may be replaced by 240V on demand.
Power input: 35VA approx.
Tubes used: 2 × EC81; 1 × 6J6; 1 × 6X4.
Weight: 20lb 8oz (9·300kg).
Dimensions: 20 × 11½ × 7¾in. (510 × 195 × 195mm) overall. Price **£48·50** inc. VAT.

Large selection of RF PLUGS AND SOCKETS
Available ex-stock: BNC plugs 50 **30p**; BNC sockets 50 **25p**; N. type plug 50 **50p**;
Burndept plugs **40p**; Burndept sockets **20p**; All plugs and sockets are brand new. Please add appropriate amount for postage.

AVO VALVE TESTERS
Brief-case type 160. Full working condition throughout, **£65.**

PLEASE ADD 8% VAT TO THE TOTAL AMOUNT WHEN ORDERING. INCORRECT AMOUNTS WILL CAUSE DELAY IN DESPATCH.

PARKERS SHEET METAL FOLDING MACHINES HEAVY VICE MODELS

With Bevelled Former Bars

No. 1.	Capacity 18 gauge mild steel x 36in. wide	...	£21 carr. free
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Also new bench models. Capacities 36in. x 18 gauge **£40.** 24in. x 16 gauge **£38.** Carriage free. Add 8% VAT to total price of machine.
End folding attachments for radio chassis. Tray and Box making. Steel Angle 36in. model, **40p** per. ft. Other models **30p.** The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals.

One year's guarantee. Money refunded if not satisfied. Send for details.

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Balmaha House, 75/77 Sandy Lane, Melton Mowbray, Leics. LE13 0EN

ELECTRONIC COMPONENT STOCKISTS AND DISTRIBUTORS

I/Cs '74' series TTL. Full range. **LINEAR I/Cs** μa 741, 709, 740, LM305, 723, 309K, 555V, etc. **TRANSISTORS:** BC107, 108, 109 Family ZTX, 2N3055 (50p), 2N2613, 2N2904, 2N3866, BCY34, BCY70, BC204 and many others. **DIODES:** General purpose and zeners 400mW to 1·5W, 50V–800V. Thyristor firing circuits in module form. Electronic plug-in timers, 8 pin and 11 pin Cradle relays and bases (PYE-TMC) 2 c/o and 4 c/o. B and R relays 2 c/o and 3 c/o all voltages. **CERMET RECTILINEAR POTENTIOMETERS** 0·75W and 1W. Other items to clear: new, not normally stocked. **DEAC RE-CHARGEABLE BATTERIES:** Capacity, 4ah/10hr rate. Physical size as HP2 £1·50 each. **KEYSWITCH RELAYS:** Plug-in types KMK2P, KMK3P 110V a.c., 230V a.c. 5A contacts £0·90 each. 3 pole sockets for relays £0·10 each. **DECIMAL THUMBWHEEL SWITCHES:** 10-position, showing 0–9 by illuminated rotors. Only decimal output available (1 output per pos.) £0·80. End pieces for panel mounting of switches £0·40. **VEROBOARD:** 0·1in, 0·15in and 0·2in. Pitch 0·2in in regular size of 3¾in × 3¾in. Cards of 10. £0·80. **PYE-TMC RELAYS:** Cradle type, direct P.C. mount. 0·1in grid matrix. Suitable for 12V, 24V or 48V, 2 pole and single pole £0·50 each. **MAGNETIC DEVICES RELAYS:** Open type 1 pole and 2 pole c/o, 110V d.c. £0·50.

MANY OTHER ITEMS

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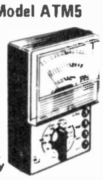
ASK LASKYS and make no mistake

TMK 200 MULTIMETER KIT
Build yourself a quality 20000 opv. multimeter and save money. Complete kit with meter scale, movement and rotary range selector ready mounted in cabinet. All parts, batteries, test prods and instructions. Ranges: 0/0.6/6/30/120/600/1200V D.C. 0/6/30/120 600/1200V A.C. Current: 0/0.6/6/60/600mA. Resistance: 0/10/100K/1/10 Meg ohms. Decibels: —20 to +63db. Size: 90 x 150 x 35mm

OUR PRICE £7.95 P&P 30p.

AUDIOTRONIC Model ATM1
Top value 1,000 opv pocket multi-meter. Ranges:— 0/10/50/250/1,000 volt AC and DC. DC current 0-1mA/100mA. Resistence: 0/150k ohms. Decibels: —10 to +22dB. Size 90 x 60 x 28mm. Complete with test leads.

OUR PRICE £3.25 P&P 15p

AUDIOTRONIC Model ATM5
Jewel movement, attractively moulded case with edgwise ohms adjustment. Ranges: 0-3/15/150/300/1200V AC, (2500 opv). 0-6/30/300/600V DC (5000 opv). 0-300 uA/0-300mA DC. Resistance: x 10 & x 100. —10 to +16dB. Supplied with battery test leads and data booklet. Size: 121 x 73 x 29mm.

OUR PRICE £3.95 P & P 20p

MODEL TH12
20,000 opv. Overload protection. Slide switch selector. 0/0.25/2.5/10/50/150/1000V DC. 0/10/50/250/1000V AC. 0/50uA/25/250mA DC. 0/3k/30k/300k/3 Megohms. —20 to +50dB.

OUR PRICE £5.95 P&P 30p

HIOKI 720X VOM
A versatile, accurate measuring instrument. 20,000 opv. 0/5/25/100/500/1000V DC. 0/10, 50/250/1000V AC. 0—50uA/250mA. 0—20k/2 Megohms.

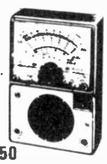
OUR PRICE £5.97 P&P 30p

MODEL PL436
20,000 opv DC. 8000 opv AC. Mirror scale ·6/3/12/30/120/600V DC. 3/30/120/600V DC. 50/600μA/60/600mA. 10/100K/1 Meg/10 Meg Ohm. —20 to +46 dB.

OUR PRICE £6.97 P&P 30p.

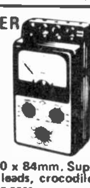
U4323 MULTIMETER
20,000opv. Simple unit with audio/IF oscillator. Suitable for general receiver tuning. Ranges: 0.5/2.5/10/50/250/500/1000V DC. 2.5/10/15/250/500/1000V AC. 0.05/0.5/5/50/500mA DC. Resistance: x 10, x 100, x 1,000, x 10,000 (50Ω, 500Ω, 5kΩ, 50kΩ centre scale) Battery operated. Size: 160 x 97 x 40mm. Supplied in carrying case complete with test leads.

OUR PRICE £7.70 P&P 30p

HIOKI 730X
30,000 opv. Overload protection. 6/30/60/300/600/1200V DC. 12/60/120/600/1200V AC. 60/μA/30mA/300mA. 2K/200K/2 Meg Ohm. —10 to · 63 dB.

OUR PRICE £7.50 P&P 30p.

U4324 MULTIMETER
High sensitivity, overload protected. 20,000opv. Ranges: 0.6/1.2/3/12/30/60/120/600/1200V DC. 3/6/15/60/150/300/600/900V AC. Current: 0.06/0.6/6/60/600mA/3A DC. 0.3/3/30/300mA/3A AC. Resistence: 25/500 ohms/0.5/5/50/500k ohms/5 Mohms. Decibels: —10 to +12dB. Size 167 x 98 x 63mm. Supplied complete with test leads, spare diode and instructions.

OUR PRICE £9.25 P&P 30p

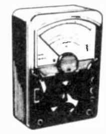
U435 MULTIMETER
20,000opv. Ranges: 75mV/2.5/10/25/100/250/500/1000V DC. 2.5/10/25/100/250/500/1000V AC. Current: 50uA/1/5/25/100mA/0.5/2.5A DC. 5/25/100mA/0.5/2.5A AC. Resistance: 0.3/3/30/300k ohms. Size: 205 x 110 x 84mm. Supplied complete with leads, crocodile clips and steel carrying case.

OUR PRICE £8.75 P&P 30p

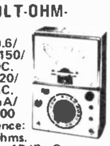
U4312 MULTIMETER
extremely sturdy instrument for general electrical use. 667opv. 0/0.3/1.5/7.5/30/60/150/300/600/900V DC & 75mV. 0/0.3/1.5/7.5/30/60/150/300/600/900V AC. 0/300uA/1.5/6/15/150/60/600mA/1/1.5/6A DC. 0/1.5/6/15/60/150/600mA/1.5/6A AC. 0/200/3k/30k ohms. DC accuracy 1%. AC 1.5%. Knife edge pointer, mirror scale. Complete with sturdy metal carrying case, leads and instructions.

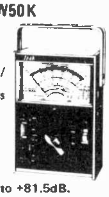
OUR PRICE £10.25 P&P 50p

U91 Clamp VOLT AMMETER
For measuring AC voltage and current without breaking circuit. Ranges: 300/600V AC. Current: 10/25/100/250/500A. Accuracy 4%. Size 283 x 94 x 36mm. Complete with carrying case, leads and fuses.

OUR PRICE £13.50 P&P 30p

MODEL 500
30,000 opv with overload protection. Mirror scale. 0/0.5/2.5/10/25/100/250/500/1000V DC. 0/2.5/10/25/100/250/500/1000V AC. 0/50uA/5/50/500mA. 12A DC. 0/60k/6 meg/60 megohms.

OUR PRICE £13.95 Carr. paid
Case for above £1.75

HIOKI 750X VOLT-OHM-MILLIAMETER
43 ranges: 0—0.3/0.6/1.5/3/6/12/30/60/150/300/600/1,200V DC. 0—3/6/15/30/60/120/300/600/1,200V AC. Current: 0—30/60uA/1.5/3/15/30/150/300 mA/6/12A. Resistence: 0—3/300k/3/30Mohms. Decibels: —10 to +17dB. Output:— 0—3/6/15/30/60/120/300V. Accuracy ± 3% DC, ± 4% AC. Sensitivity: 50,000 opv DC. 5,000 opv AC. 4 inch meter. Built in protection. Size: 57 x 102 x 153mm.

OUR PRICE £11.95 P&P 40p

TMK MODEL TW50K
46 ranges, mirror scale. 50k/V DC 50k/V AC. DC Volts: 0.125/0.25/1.25/2.5/5/10/25/50/125/250/500/1000. AC Volts 1.5/3/5/10/25/50/125/250/500/1000. DC current 25/50uA/2.5/5/25/50/250/500mA/5/10A. Resistance: 10k/100k/1 Meg/10 Meg ohms. —20 to +81.5dB.

OUR PRICE £12.50 P&P 20p

HIOKI MODEL 700X
100,000opv. Overload protection. Mirror scale. 0.3/0.6/1.2/1.5/3/6/12/30/60/120/300/600/1200V DC. 1.5/3/6/12/30/60/150/300/600/1200V AC. 15/30uA/3/6/30/60/150/500mA/6/12A DC. 2k/200k/2M/20MOhms. —20 to +63dB.

OUR PRICE £14.95 P&P 30p

Model HT100B4 MULTIMETER
Overload protected, shock proof circuits. 9.5uA Meter with mirror scale. Sensitivity 100kV. Polarity change switch. Ranges: 0.5/2.5/1-/50/250/500/1,000 Volts DC. 2.5/10/50/250/1,000 Volts AC. DC resistence' 0—20/200k/2/20 Meg. ohms. DC current:— 10/250uA/2.5/25/250 mA/10A. AC current:—0—10A. —20 to +62dB. Operates from 2 x 1.5V batteries. Size: 180 x 134 x 79mm.

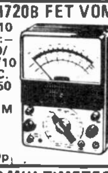
OUR PRICE £17.50 P&P 40p

MODEL AS.1000 VOM
100,000 opv. Mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1200V DC. 0/6/30/120/300/600V AC. 0/10μA/6/60/300mA/12 Amp. 0/2K/200K/2M/200 Meg Ohm. - 20 to - 17 dB.

OUR PRICE £17.50 P&P 30p.

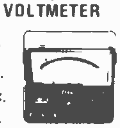
MODEL C7202EN
20,000 o.p.v. DC. 10,000 o.p.v. AC Mirror Scale. 5/25/50/250/500/1000/2500 V. DC. 10 50/100/500/1000 V. AC. DC Resistance x 10, x 1000 (30Ω centre scale) DC Current 50uA/2.5mA/250mA. —20 to +68dB.

OUR PRICE £6.95 P & P 30p

KAMODEN HM720B FET VOM
Input impedence 10 Megohms. Ranges:— 0/.25/1/2.5/10/50/1000V DC. 0/2.5/10 50/250/1000V AC. 0/25uA/2.5/25/250 mA DC. 0/5k/50k/500k/5 M 500 Megohms

OUR PRICE £21.00 P & P 40p

KAMODEN 360 MULTIMETER
High sensitivity. DC 100kohm/V AC 10kohm/V 5" mirror scale, overload protected. Ranges: 0.5/2.5/10/50/250/1000V DC. 5/10/50/250/1000V AC. Current: 0.01mA/0.5/5/50/500mA/10A. Resistance: 0.1/1/10/100 ohms/1/10/100k ohms/10/100M ohms. Decibels —20 to +62dB. Battery operated. Size: 180 x 140 x 80mm. Supplied complete with, test leads etc.

OUR PRICE £17.50 P & P 40p

TMK MODEL 117 FET ELECTRONIC VOLTMETER
Battery operated. 11 Meg input, 26 ranges. Large 4¼" mirror scale. Size: 149x117x60mm. 0.3—12000V DC. 3—300V RMS AC. 8—800V P.P. DC current 0.12—12mA. Resistence up to 2000MOhms. Decibels: —20 to +51dB. Supplied complete with leads and instructions.

OUR PRICE £18.50 P&P 20p

TMK 100K LAB TESTER
100,000opv. 6½" scale. Buzzer short circuit check. Sensitivity 100,000 opv DC. 5k/V AC DC Volts: 0.5/2.5/10/50/250/1000V AC. 3/10/50/250/500/1000V DC. currant 10/100μA/10/100/2.5/10A. Resistance: 1k/10k/100k/10 Meg/100 Meg ohms. Decibels: —10 to +49dB. Plastic case with carrying handle. Size: 190 x 172 x 99mm.

OUR PRICE £19.95 P&P 30p

370WTR MULTIMETER
Features AC current ranges. 20,000opv. 0/0.5/2.5/10/50/250/500/1000V DC. 0/2.5/10/50/250/500/1000V AC. 0/50uA/1/10/100 mA/1/10A DC. 0/100mA/1/10A AC. 0/5k/50k/500k/5 Meg/50 Meg. Decibels: —20 to +62dB.

OUR PRICE £19.95 P&P 30p

KAMODEN 72.200 Multitester
High sensitivity tester. 200,000 opv Overload protected. Mirror scale. Ranges:—0/.06/.3 3/30/120/600/1200V DC. 0/3 12/60/300/11200 V AC. 0/6uA/1.2mA/120mA/600mA/12A DC 0/12A AC. —20 to +63dB. 0/2k/200k/2 Meg/200 Megohms.

OUR PRICE £22.50 P&P 30p

U4317 MULTIMETER
High sensitivity instrument for field and laboratory work. Knife edge pointer, 86mm. mirror scale. Overload protection. Ranges: 100mV/0.5/2.5/10/25/50/100/250/500/1000 V DC. 0.5/2.5/10/25/50/100/250/500/1000V AC. Current: 50uA/0.5/1/5/10/50/250mA/1/5A DC. 0.25/0.5/1/5/10/50/250mA/1/5A AC. Resistance: 0.5/10/100/200 ohms/1/3/30/300k ohms. Decibels: —5 to +10dB Battery operated. Size: 210 x 115 x 90mm. Supplied in carrying case complete with leads.

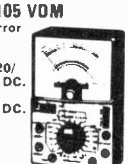
OUR PRICE £16.50 P&P 40p

MODEL C7208FM
30,000 opv DC. 15,000 opv AC. 6/3/15/60/300/600/1200 V. DC. 6/30/120/600/1200 V. AC. DC Resistance x 1, x 10, x 100, x 1000 (50Ω centre scale) DC Current 30uA/3/30/600mA. —20 to +63dB.

OUR PRICE £8.95 P & P 30p

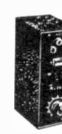
MODEL U4311 Sub-standard Multi-range Volt-Ammeter
Sensitivity 330 Ohms/Volt AC and DC. Accuracy 0.5% DC. 1% AC. Scale length: 165mm. 0/300/750uA/1.5/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A DC. 0/3/7.5/15/30/75/150/300/750mA/1.5/3/7.5A AC. 0/75/150/300/750mV/1.5/3/7.5/15/30/75/150/300/750V DC. 0/750mV/1.5/3 /7.5/15/30/75/150/300/750V AC. Automatic cut out device. Supplied complete with test leads, manual and test certificates.

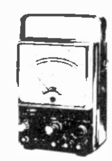
OUR PRICE £52.00 P&P 50p

MODEL AF.105 VOM
50,000 opv. Mirror scale. Meter protection. 0/ 3/3/12/60/120/300/600/1200V DC. 0/6/30/120/. 300/600/1200V DC. 0/30μA/6/60/300 mA/12 Amp. 0/10K/1m/10m/100 Meg Ohms. — 20 to · 17dB.

OUR PRICE £12.50 P&P 30p.

LB3 TRANSISTOR TESTER
Tests ICD and B. PNP/NPN. Operates from 9V battery. Instructions supplied.

OUR PRICE £3.95 P&P 20p

LB4 TRANSISTOR TESTER
Tests PNP or NPN transistors. Audio indication. Operates on two 1.5V batteries. Complete with instructions etc.

OUR PRICE £4.50 P&P 20p

KAMODEN TT35 TRANSISTOR TESTER
High quality instrument to test reverse leak current and DC current. Amplification factor of NPN, PNP, diodes, transistors, SCR's etc. 4" square clear scale meter. Operates from internal batteries. Complete with instructions, leads and carrying handle.

OUR PRICE £17.50 P & P 40p

U4341 Multimeter & Transistor Tester
27 ranges. 16,700opv. Overload protected. Ranges: 0.3/1.5/6/30/60/150/300/900V DC. 1.5/7.5/30/150/300/750V AC. Current: 0.06/0.6/6/60/600mA DC. 0.3/3/30/300mA AC. Resistance: 0.06/0.6/2/6/20/60/200k ohms/2 Mohms. Battery operated. Supplied complete with probes, leads and steel carrying case. Size: 115 x 215 x 90mm.

OUR PRICE £10.50 P&P 30p

S100TR MULTIMETER TRANSISTOR TESTER
100,000opv. Mirror scale. Overload protection. 0/0.12/0.6/3/12/30/120/600V DC. 0/6/30/120/600V AC. 0/12/600uA/12/300mA/6/12A DC 0/10k/1 Meg/100 Meg. —20 to +50dB. 0.01—0.2 MFD. Transistor tester measures Alpha, Beta and ICO. Complete with instructions, batteries and leads.

OUR PRICE £19.95 P&P 25p

ALL PRICES EXCLUDE VAT

Also see following pages

SINCLAIR DM2 DIGITAL MULTIMETER

Will measure AC and DC volts, AC and DC current, and resistance in a total of 20 ranges. The large light emitting diode display will read up to 1999 and automatically indicate polarity. Indication of positive and negative overload is also provided. The instrument is fitted with a combined carrying handle and bench stand and sockets are provided for the connection of an external power supply.

RANGES:
DC VOLTS: 1v, 10, 100v, 1000v.
AC VOLTS: 1v, 10v, 100v, 1000v.
DC CURRENT: 1mA, 10mA, 100mA, 1000mA.
AC CURRENT: 1mA, 10mA, 100mA, 1000mA.
RESISTANCE: 1k, 10k, 100k, 1000k.

OUR PRICE £59.95 P & P 50p

SWR METER Model SWR3

Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 30p

C15 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP. Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1–25; HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3–25 Preset triggered sweep 1–3000usec. Free running 20–200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115–230V AC.

OUR PRICE £43.00 Carr. paid

RUSSIAN CI16 Double Beam OSCILLOSCOPE

5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz–1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

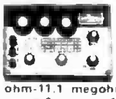
OUR PRICE £87.00 Carr. paid

MODEL TE15 GRID DIP METER

Transistorised. Operates as Grid Dip, Oscillator, Absorbtion Wave Meter and Oscillating Detector. Frequency range 440kHz–280MHz in six coils. 500uA meter. 9V battery operation. Size: 180 x 80 x 40mm.

OUR PRICE £17.50 P&P 30p

TRANSISTORISED L.C.R. A.C. BR/8 MEASURING BRIDGE



A new portable bridge offering excellent range and accuracy at low cost. Resistance 6 ranges: 0.1 ohm-11.1 megohm ± 1% Inductance 6 ranges: 1 microhenry-111 henries ± 2% Capacity: 6 ranges: 10pf-1110 mfd ± 2% Turns Ratio: 6 ranges: 1:1 1000-1:11100 ± 1% Bridge Voltage at 1,000cps. Operated from 9-volt battery. 100 micro-amp meter indication. Size 7⅛" x 5" x 2"

OUR PRICE £25.00 P&P 30p

TE-20D RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kHz-500 MHz on 6 bands. Directly calibrated. Variable R F attenuator audio output. Xtal socket for calibration. 220/240V a.c. Brand new with instructions. Size 140mm x 215mm x 170mm.

OUR PRICE £17.50 P&P 50p

TE22 SINE SQUARE WAVE AUDIO GENERATOR

Sine 20cps to 200kHz on 4 bands. Square 20 cps to 30 kHz. Output impedence 5000 Ohms. 200/250V AC operation. Supplied brand new guaranteed, with instruction manual and leads.

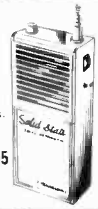
OUR PRICE £24.95 P&P 50p

ARF 300 AF/RF SIGNAL GENERATOR

All transistorised compact fully portable. AF sine wave 18Hz to 220 kHz. AF square wave 18Hz to 100k Hz. Output Square/Sine wave 10V. P-P RF 100kHz to 200MHz. Output 1V maximum. 220/240V AC operation. Complete with instructions and leads.

OUR PRICE £37.50 P&P 50p

WALKIE TALKIES

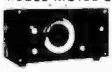


SKYFON NV7
Super low cost transmitter/receivers. 100MW with call buzzer and on/off volume control. 7 transistors. Telescopic rod antenna.

OUR PRICE £28.95 per PAIR P &P 50p

NOT LICENSABLE IN THE U.K.

MODEL MG100 SINE SQUARE WAVE AUDIO GENERATOR



Range 19–220,000Hz Sine Wave 19–100,000 Hz Square Wave. Output Sine or Square wave 10v. P. to P. Size 180 x 90 x 90mm. Operation 220/240v. A.C.

OUR PRICE £19.95 P&P 50p

POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Single hole fixing. ¼" diameter shafts. Bulk quantities available.

25 WATT 10/25/50/100/500/1000/2500 ohms — **£1.15** P&P 10p

50 WATT 10/50/100/250/500/1500/5000 ohms — **£1.62** P&P 10p

100 WATT 1/5/10/25/50/250/500/2500 ohms — **£2.34** P&P 15p

SPECIAL PURCHASE LIMITED QUANTITY! Tannoy 12" DR/8 Bass Speakers

8 ohms. 30 watt. Heavy duty, ideal for Hi-Fi P.A. Group.

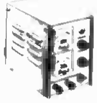
OUR PRICE £12.50. P&P 50p.

AUDIOTRONIC LE-102A INTERCOM

Beautifully made and finished in twotone ivory/buff, the LE-102A is useful in the home, office or shop and is suitable for use as baby alarm. Wall or desk mounting 57mm speaker mic gives clear 2-way communication with on/off and volume control on master unit. Operates on 9V batt. Approx. 60ft lead.

OUR PRICE £3.95 P & P 30p

PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5–20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

OUR PRICE £19.95 P&P 50p

TRITON 4318 PORTABLE 8 TRACK CARTRIDGE PLAYER WITH MW/LW RADIO

Will play 8 track stereo cartridge monaurally. Channel selector switch. Covers medium and long wave bands. Volume and tone controls. Earphone socket. Battery Mains operation.

OUR PRICE £11.95 P & P 50p

EA41 REVERBERATION AMPLIFIER

Self contained, transistorised, battery operated. Simply plug in microphone, guitar etc. and output to your amplifier. Volume control and depth of reverberation control. Beau- walnut cabinet. 184 x 77 x 108mm.

OUR PRICE £7.50 P&P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20–20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms. 20–12,000Hz. Complete with lead and plug.

OUR PRICE £2.25 P&P 30p

TE1035 Stereo HEADPHONES

Low cost with excellent response. Foam rubber earcups. Adjustable headband. 8 ohms impedence. Frequency response 25Hz–18kHz. Complete with cable and stereo jack plug.

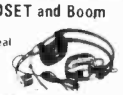
OUR PRICE £2.60 P&P 30p

SDH8V MONO/STEREO HEADPHONES

Volume control for each channel. 4/16 ohms impedence. Frequency response 20Hz–18kHz. Complete with 10ft. coiled lead and jack plug.

OUR PRICE £4.97 P&P 30p

BH001 HEADSET and Boom Microphone



Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

OUR PRICE £5.95 P&P 30p

HANIMEX HRC 3075 CASSETTE RADIO

Covers Medium and FM wave-bands. Slider volume and tone controls. Battery Mains operation. Will record direct from radio or through built in condenser microphone. Complete with batteries, earphone, and cassette.

OUR PRICE £24·30 P & P 50p

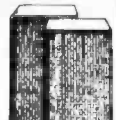
SPECIAL OFFER! CONVERT YOUR STEREO SYSTEM TO 4D SOUND FOR UNDER £16

Exclusive offer of GOODWIN 4-CHANNEL CONVERTER and a pair of AD15 10 watt 8 ohm bookshelf speakers enables you to add 4D sound to your existing system. Complete with simple connection details. Normal retail value £25.50.

OUR PRICE £15.80 P & P £1

GOODWIN CONVERTER available separately £3.95 P & P 50p.

SPECIAL BARGAIN !! STEREOSOUND SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size: 368 x 229 x 190mm. 8 ohms. 8 watts RMS, 16 watts peak. Complete with Din lead.

OUR PRICE £12.95 PAIR P&P 50p

FM TUNER CHASSIS

6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88–108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £8.95 P&P 20p

Stereo Multiplex Adaptor £5.95 extra

Model A1018 FM TUNER

6 transistor high quality unit—3 IF stages and double tuned discriminator. For use with most amplifiers. Covers 88–108MHz. Powered by 9V battery.

OUR PRICE £13.50 P&P 30p

Stereo multiplex adapter £5.95 extra.

ELECTRONIC CALCULATORS

We carry a tremendous range of both pocket and desk calculators from as little as **£8.90**. Owing to the demand it is not possible to include them in this advertisement, so send for our latest price list or call into any branch.

MINIATURE ORGAN MUSIC MASTER AM100

Spanning nearly two octaves, including semi-tones. This instrument will give hours of enjoyment to all the family. Beautifully finished. The Keyboard range can be adjusted to be in tune with any instrument. Operates from internal 9V battery. Fitted with on off switch, vibrato switch, earphone socket and external 9V D.C. socket.

OUR PRICE £7.95 P&P 50p.

BINATONE DIGITAL CLOCK

Attractive ivory case. Large clear numbers for hours, minutes and seconds. A.C. 240V operation. Size approx. 6½ x 3 x 3½ inches.

OUR PRICE £4.50 P&P 50p.

SINCLAIR IC12 INTEGRATED CIRCUIT AMPLIFIER

complete with printed circuit mounting board.

OUR PRICE £1.50 P & P 15p.

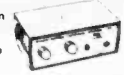
SINCLAIR Project 80 Modules

Z40 Power Amp	£5.95	P & P 15p
Z60 Power Amp	£7.45	P & P 15p
Stereo 80 Pre-Amp	£13.95	P & P 15p
Active Filter Unit	£7.45	P & P 15p
FM Tuner	£13.95	P & P 15p
Stereo Decoder	£8.95	P & P 15p
PZ5 Power Supply	£5.95	P & P 30p
PZ6 Power Supply	£8.95	P & P 30p
PZ8 Power Supply	£8.45	P & P 30p
Transformer for PZ8	£4.05	P & P 50p
IC 20 Stereo Amp. kit	£7.95	P & P 15p
PZ20 Power Supply kit	£5.45	P & P 30p

SINCLAIR Project 80 Packages

2xZ40 Stereo 80 PZ5	£28.60	P & P 35p each
2xZ40 Stereo 80 PZ6	£31.30	
2xZ60 Stereo 80/PZ8	£33.55	

TE1021 Stereo Listening Station



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on–off slide switch, stereo headphone socket.

OUR PRICE £2.25 P&P 15p

AUDIOTRONIC LOW NOISE CASSETTES

TYPE	5	10	25
C60	£1.57	£3.00	£7.08
C90	£2.24	£4.25	£10.00
C120	£2.73	£5.17	£12.24

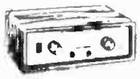
P&P 3p each. 10 and over Post Free

MP7 MIXER-PREAMPLIFIER

5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

OUR PRICE £8.97 P&P 20p

AUDIOTRONIC AHA101 Stereo Headphone Amplifier



All silicon, transistor amplifier operates from magnetic, ceramic or tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9V battery. INPUTS: 5mV and 100mV. OUTPUT: 50mV per channel.

OUR PRICE £8.50 P&P 30p

HIGH QUALITY CONSTRUCTION KITS

JOSTY KIT

WE ARE APPOINTED STOCKISTS AT Oxford Street, 42 & 257 Tottenham Court Road, 34 Lisle Street, 152 Fleet Street, 311 Edgware Road, CROYDON BIRMINGHAM KINGSTON LEICESTER NORTHAMPTON SOUTHEND TUNBRIDGE WELLS WOLVERHAMPTON branches, or by Mail Order.

All kits are complete with comprehensive easy to follow instructions and covered by full guarantee.

Post and Packing 15p per kit.

AF20 Mono amplifier	£5.61
AF25 Mixer	£3.29
AF30 Mono pre-amplifier	£3.20
AF35 Emitter amplifier	£2.42
AF80 0.5W mic. amplifier	£4.86
AF305 Intercom	£7.67
AF310 2 Mono Amplifier	£7.55
M160 Multi-vibrator	£2.18
M1302 Transistor tester	£8.33
M191 VU Meter	£5.37
M192 Stereo balance meter	£5.93
LF380 Quadraphonic device	£8.42
AT5 Automatic light control	£3.75
AT30 Photo cell switch unit	£6.68
AT50 400W triac light dimmer/speed control	£5.18
AT56 2,200W triac light dimmer/speed control	£6.75
AT60 1 channel light control	£10.82
AT65 3 channel light control	£16.52
GU330 Tremolo unit	£8.10
HF61 Diode detector	£3.87
HF65 FM transmitter	£3.21
HF75 FM receiver	£3.66
HF310 FM tuner	£16.32
HF325 Deluxe FM tuner	£26.33
HF330 Decoder (HF310/325)	£10.55
GP310 Stereo pre-amplifier for use with 2 x AF310	£22.98
GP312 Circuit board	£10.02
GP304 Circuit board	£5.33
HF380 lw/vhf aerial amplifier	£6.02
HF395 broadband aerial amp.	£2.10
NT10 Stabilised power supply 100mA, 9V	£6.27
NT300 Stabilised p. supply	£13.16
NT310 Power Supply 240 V AC or 2 x 18 V D.C. at 2 amps	£5.64
NT305 Voltage converter	£5.64
NT315 Power supply 240V AC to 4.5/15V DC. 500mA	£12.06

Amateur Electronics by Josty-Kit, the professional book for the amateur—covers the subject from basic principals to advanced electronic techniques. Complete with circuit board for AE1 to AE10 listed below.

OUR PRICE £3.30 (No VAT) P&P 25p plus VAT.

AE1 100mW output stage	£1.55
AE2 Pre-amplifier	£1.32
AE3 Diode receiver	£2.05
AE4 Flasher	£1.26
AE5 Astable multi-vibrator	£1.14
AE6 Monostable multi-vibrator	£1.11
AE7 RC generator	£1.08
AE8 Bass filter	£1.05
AE9 Treble filter	£1.05
AE10 CCIR filter	£1.05

Also see previous page

ALL PRICES EXCLUDE VAT

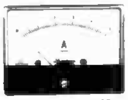
SEW PANEL METERS

SEW PANEL METERS ARE STOCKED AT OUR 3 LISLE ST., 311 EDGWARE RD., & 152 FLEET ST., BRANCHES or order by post.

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS, EDUCATIONAL AUTHORITIES ETC.

Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

CLEAR PLASTIC MODEL SD640
Size: 85 x 64mm

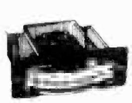


50uA	£3.90	10V DC	£3.75
100uA	£3.85	20V DC	£3.75
200uA	£3.80	50V DC	£3.75
500uA	£3.75	300V DC	£3.75
50-0-50uA	£3.85	15V AC	£3.85
100-0-100uA	£3.80	300V AC	£3.85
1mA	£3.75	VU Meter	£4.00
5mA	£3.75		
10mA	£3.75		
50mA	£3.75		
100mA	£3.75		
500mA	£3.75		
1A DC	£3.75		
5A DC	£3.75		
10A DC	£3.75		
5V DC	£3.75		

CLEAR PLASTIC MODEL SW100
Size: 100 x 80mm

50uA	£4.70	150V AC	£4.55
100uA	£4.60	300V AC	£4.55
500uA	£4.40	VU Meter	£5.00
50-0-50uA	£4.60		
100-0-100uA	£4.55		
1mA	£4.40		
1A DC	£4.40		
5A DC	£4.40		
20V DC	£4.40		
50V DC	£4.40		
300V DC	£4.40		

EDGWISE MODEL PE70
Size: 90 x 34mm



50uA	£4.25
100uA	£4.20
200uA	£4.15
500uA	£4.00
50-0-50uA	£4.20
100-0-100uA	£4.15
1mA	£3.95
300V AC	£4.05
VU Meter	£4.40

MODEL ED107 EDUCATIONAL METER
Size: 100 x 90 x 150mm including terminals

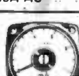
A range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working.

50uA	£8.70	20V DC	£7.80
100uA	£8.10	50V DC	£7.80
50-0-50uA	£8.10	300V DC	£7.80
1mA	£7.80	500mA/5A DC	£8.80
1-0-1mA	£7.80	5V/50V DC	£8.80
1A DC	£7.80	5V/15V DC	£8.80
5A DC	£7.80	1/5A DC	£8.80
5V DC	£7.80		
10V DC	£7.80		
15V DC	£7.80		

CLEAR PLASTIC MODEL MR 85P
Size: 120 x 110mm

50uA	£6.60	300V DC	£5.40
100uA	£5.55	15V AC	£5.45
200uA	£5.50	300V AC	£5.45
500uA	£5.40	S Meter 1mA	£5.35
50-0-50uA	£5.55	VU Meter	£5.70
100-0-100uA	£5.50	1A AC	* £5.35 *
500-0-500uA	£5.35	5A AC	* £5.35 *
1mA	£5.35	10A AC	* £5.35 *
1-0-1mA	£5.35	20A AC	* £5.35 *
5mA	£5.35	30A AC	* £5.35 *
10mA	£5.35		
50mA	£5.35		
100mA	£5.35		
500mA	£5.35		
1A DC	£5.35		
5A DC	£5.35		
15A DC	£5.35		
30A DC	£5.55		
10V DC	£5.35		
20V DC	£5.35		
50V DC	£5.35		
150V DC	£5.35		

240° Wide Angle 1mA METERS

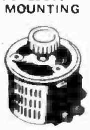


MW1-6 60 x 60 mm
£6.50 P & P 15p
MW1-8 80 x 80mm
£6.90 P&P 15p

YAMABISHI VARIABLE VOLTAGE TRANSFORMERS

Excellent quality at low cost. Input 230V 50/60Hz. Output 0–260V.

MODEL S260 BENCH MOUNTING



		P&P
1A	£10.50	50p
2.5A	£12.00	50p
5A	£17.50	50p
8A	£30.35	£1.00
10A	£33.75	£1.00
12A	£35.40	£1.00
20A	£85.00	£1.50
25A	£95.00	£1.50
40A	£120.00	£1.50

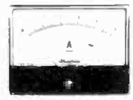
MODEL S260B PANEL MOUNTING

2.5A	£12.00	50p

ALL PRICES EXCLUDE VAT

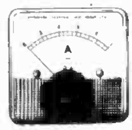
*Items with asterisk are Moving Iron type, all others are Moving Coil

CLEAR PLASTIC MODEL SD830
Size: 110 x 83mm



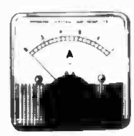
50uA	£4.40	10V DC	£4.20
100uA	£4.35	20V DC	£4.20
200uA	£4.30	50V DC	£4.20
500uA	£4.25	300V DC	£4.20
50-0-50uA	£4.35	15V AC	£4.30
100-0-100uA	£4.30	300V AC	£4.30
1mA	£4.20	VU Meter	£4.50
5mA	£4.20		
10mA	£4.20		
50mA	£4.20		
100mA	£4.20		
500mA	£4.20		
1A DC	£4.20		
5A DC	£4.20		
10A DC	£4.20		
5V DC	£4.20		

CLEAR PLASTIC MODEL MR 45P
Size: 50 x 50mm



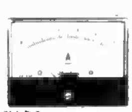
50uA	£3.30	300V AC	£3.15
100uA	£3.25	S Meter 1mA	£3.05
200uA	£3.20	VU Meter	£3.50
500uA	£3.10	1A AC	* £3.05 *
50-0-50uA	£3.25	5A AC	* £3.05 *
100-0-100uA	£3.20	10A AC	* £3.05 *
500-0-500uA	£3.05	20A AC	* £3.05 *
1mA	£3.05	30A AC	* £3.05 *
5mA	£3.05		
10mA	£3.05		
50mA	£3.05		
100mA	£3.05		
500mA	£3.05		
1A DC	£3.05		
5A DC	£3.05		
10V DC	£3.05		
20V DC	£3.05		
50V DC	£3.05		
300V DC	£3.05		
15V AC	£3.15		

CLEAR PLASTIC MODEL MR 38P
Size: 42 x 42mm



50uA	£3.20	20V DC	£2.85
100uA	£3.15	50V DC	£2.85
200uA	£3.10	100V DC	£2.85
500uA	£2.90	150V DC	£2.90
50-0-50uA	£3.15	300V DC	£2.90
100-0-100uA	£3.10	500V DC	£2.95
500-0-500uA	£2.85	750V DC	£2.95
1mA	£2.85	15V AC	£2.95
1-0-1mA	£2.85	50V AC	£2.95
2mA	£2.85	150V AC	£2.95
5mA	£2.85	300V AC	£2.95
10mA	£2.85	500V AC	£3.10
20mA	£2.85	S Meter 1mA	£2.85
50mA	£2.85	VU Meter	£3.30
100mA	£2.85		
150mA	£2.85		
200mA	£2.85		
300mA	£2.85		
500mA	£2.85		
750mA	£2.85		
1A DC	£2.85		
2A DC	£2.85		
5A DC	£2.85		
10A DC	£2.86		
3V DC	£2.85		
10V DC	£2.85		
15V DC	£2.85		

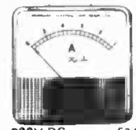
CLEAR PLASTIC MODEL SD460
Size: 59 x 46mm



50uA	£3.60	10V DC	£3.40
100uA	£3.55	20V DC	£3.40
200uA	£3.50	50V DC	£3.40
500uA	£3.45	300V DC	£3.40
50-0-50uA	£3.55	15V AC	£3.55
100-0-100uA	£3.50	300V AC	£3.55
1mA	£3.40	VU Meter	£3.75
5mA	£3.40		
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10A DC	£3.40		
5V DC	£3.40		

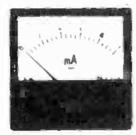
POSTAGE & PACKING 15p

CLEAR PLASTIC MODEL MR 65P
Size: 86 x 78mm



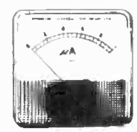
50uA	£4.05	300V DC	£3.80
100uA	£3.95	15V AC	£3.90
200uA	£3.90	50V AC	£3.90
500uA	£3.85	150V AC	£3.90
50-0-50uA	£3.95	300V AC	£3.90
100-0-100uA	£3.90	500V AC	£4.00
500-0-500uA	£3.80	S Meter 1mA	£3.90
1mA	£3.80	VU Meter	£4.20
1-0-1mA	£3.80	1A AC	* £3.80 *
5mA	£3.80	5A AC	* £3.80 *
10mA	£3.80	10A AC	* £3.80 *
50mA	£3.80	20A AC	* £3.80 *
100mA	£3.80	30A AC	* £3.80 *
500mA	£3.80	50mA AC	* £3.80 *
1A DC	£3.80	100mA AC	* £3.80 *
5A DC	£3.80	200mA AC	* £3.80 *
10A DC	£3.80	500mA AC	* £3.80 *
15A DC	£3.80		
20A DC	£3.90		
30A DC	£3.95		
50A DC	£4.15		
5V DC	£3.80		
10V DC	£3.80		
15V DC	£3.80		
20V DC	£3.80		
50V DC	£3.80		
150V DC	£3.80		

BAKELITE MODEL S80 Enlarged Window
Size: 80 x 80mm



50uA	£4.60
100uA	£4.55
500uA	£4.30
50-0-50uA	£4.55
100-0-100uA	£4.50
1mA	£4.30
1A DC	£4.30
5A DC	£4.30
20V DC	£4.30
50V DC	£4.30
300V DC	£4.30
300V AC	£4.40
VU Meter	£4.80

CLEAR PLASTIC MODEL MR 52P
Size: 60 x 60mm



50uA	£3.80	S Meter 1mA	£3.40
100uA	£3.60	VU Meter	£3.90
500uA	£3.45	1A AC	* £3.40 *
50-0-50uA	£3.60	5A AC	* £3.40 *
100-0-100uA	£3.45	10A AC	* £3.40 *
1mA	£3.40	20A AC	* £3.40 *
5mA	£3.40	30A AC	* £3.40 *
10mA	£3.40		
50mA	£3.40		
100mA	£3.40		
500mA	£3.40		
1A DC	£3.40		
5A DC	£3.40		
10V DC	£3.40		
20V DC	£3.40		
50V DC	£3.40		
300V DC	£3.40		
15V AC	£3.50		
300V AC	£3.50		

BAKELITE MODEL MR 65
Size: 80 x 80mm

25uA	£5.40	300V DC	£3.90
50uA	£4.10	30V AC	* £3.70 *
100uA	£4.05	50V AC	* £3.70 *
500uA	£3.75	150V AC	* £3.70 *
50-0-50uA	£4.05	300V AC	* £3.70 *
100-0-100uA	£4.00	500V AC	* £3.70 *
500-0-500uA	£3.70	VU Meter	£4.20
1mA	£3.70	1A AC	* £3.70 *
1-0-1mA	£3.70	5A AC	* £3.70 *
5mA	£3.70	10A AC	* £3.70 *
10mA	£3.70	20A AC	* £3.70 *
50mA	£3.70	30A AC	* £3.70 *
100mA	£3.70	50A AC	* £3.70 *
500mA	£3.70	500mA AC	* £3.70
1A DC	£3.70	50mV DC	£3.85
2A DC	£3.70	100mV DC	£3.85
5A DC	£3.70		
10A DC	£3.70		
15A DC	£3.70		
30A DC	£3.70		
50A DC	£3.90		
5V DC	£3.70		
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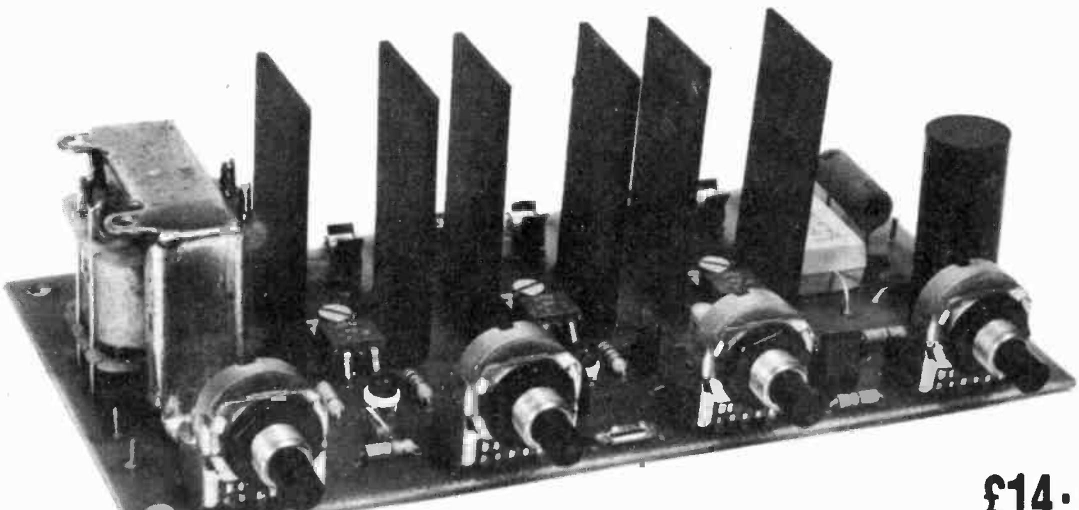

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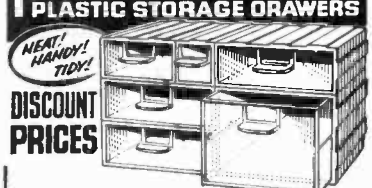

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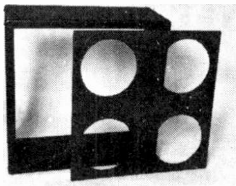
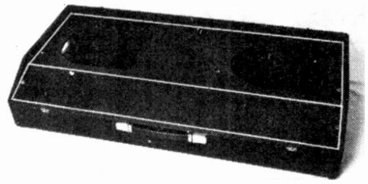


4' x 12" Cabinet



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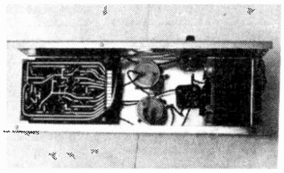

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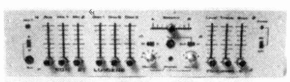
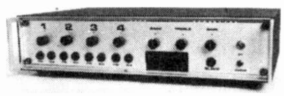
* Built to highest industrial spec.
* Price £37.00 complete



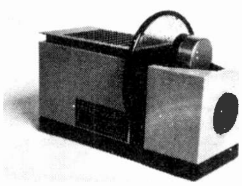
* Stereo studio disco mixer
* Full PFL and Monitor facilities
* As used by John Peel, Mark Wesley, Paul Burnett, DLT, Dave Christian, Tony Prince
* Price £120.00



ERC 100w power amplifier
* Electrolytic capacitors and second generation ICs
* Fully protected against short or open circuit
* Less than 0·1% distortion at all powers
* Rise time 4muS-stability-Unconditional Price £66.50

ALL OUR PRICES INCLUDE VAT AND UK DELIVERY

VALUE!!



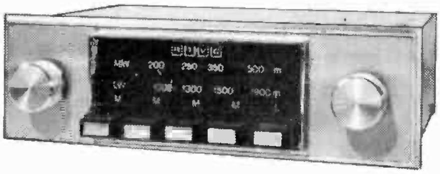
LOOK!!

Disco imp projector 150 watt tungsten
unbeatable price
Includes liquid wheel and postage
Normally sold between £24—£27·50

UNBEATABLE NOW ONLY £18

TRADE AND EXPORT ENQUIRIES WELCOME

PUSH BUTTON CAR RADIO KIT* ~ The Tourist II



NO SOLDERING REQUIRED!

NOW BUILD YOUR OWN PUSH BUTTON CAR RADIO
Easy to assemble construction kit comprising fully completed and tested printed circuit board on which no soldering is required. All connections are simple push fit type making for easy assembly. Fine tuning push button mechanism is fully built and tested to mate with printed circuit board.

TECHNICAL SPECIFICATION: (1) **Output** 4 watts R.M.S. output. For 12 volt operation on negative or positive earth. (2) **Integrated circuit** output stage, pre-built three stage IF Module. **Controls volume** manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands.

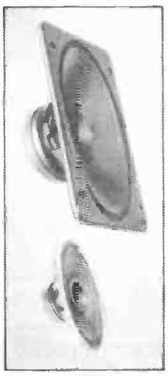
Size chassis 7" wide, 2" high and 4¾" deep approx £7.70 + 55p. p & p.

Speaker including baffle and fixing strip £1.65 + 23p. p & p.

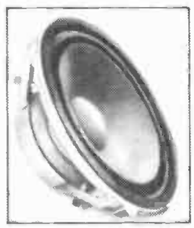
Car Aerial Recommended—fully retractable £1.37 + 20p. p. & p.

The Tourist I Kit For the experienced constructor If you can solder on a printed circuit board you can build this model.
Same technical specification as Tourist II **Price £6.60 + 55p p & p.**

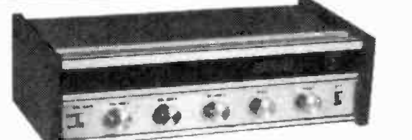
EMI SPEAKERS AT FANTASTIC REDUCTIONS



20 WATT SPEAKER SYSTEM *
System consists of a 13" × 8" (approx) eliptical woofer unit with a 8" × 5" (approx.) mid range unit incorporating parasitic tweeter and crossover components.
Technical Specification:
Bass Unit
Flux density–100 K, speech coil–1½", Cone, Triple laminated paper with P.V.C. surround.
Mid Range Unit
Flux density-33K, speech coil-1" with parasitic tweeter.
Power Handling
20 watts R.M.S., impedance – 8 ohms, frequency response – 20 Hz to 18,000 Hz.
OUR PRICE £6.60. Complete +90p p & p.



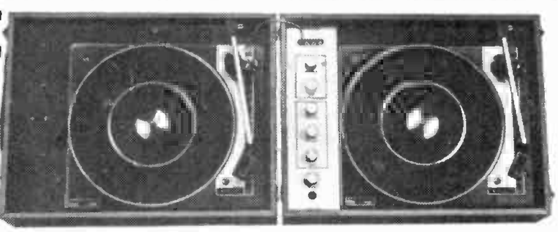
15" 14A/780 BASS UNIT
Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz flux density 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3" voice coil.
Recommended retail price £40·80.
OUR PRICE £18·70 + £1·50 p & p

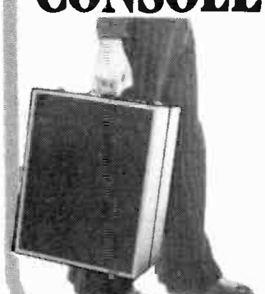


DISCO AMPLIFIER*

Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties.
Outputs 20 watts R.M.S. into 8 ohms (suitable for 15 ohms).
Inputs *4 electrically mixed inputs. *3 individual mixing controls.
*Separate bass and treble controls common to all 4 inputs.
*Mixer employing F.E.T. (Field Effect Transistors) *Solid State circuitry.
*Attractive styling.
INPUT SENSITIVITIES –Input – 1.) Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity).
–Inputs – 2), 3), 4). Medium output equipment – ceramic cartridge, tuner, tape recorder, organs, etc. – all 250mV sensitivity. AC Mains, 240V operation. Size approx: 12½" × 6" × 3½". **£15.00+60p. p & p**

PORTABLE DISCO CONSOLE *





INCORPORATES: Pre-Amp with full mixing facilities, including switched input for mic with volume control, switched input for auxiliary with volume control, bass and treble controls, volume control and blend control for turntables.

Two B.S.R. single play professional series decks, fitted with crystal cartridges.

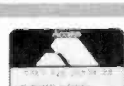
The turntables are designed and precision engineered. They combine clean modern styling with superb reproduction. Their many special features include square section aluminium tonearms, (high precision low mass design fully counterbalanced, with calibrated stylus pressure control for perfect tracking), and conveniently grouped easy to read linear controls. The turntables have viscous cueing devices which allows the tonearms to be placed or lifted at any point on the record.
The two lightweight cartridge shells have slide-in-holders to facilitate easy inspection of needles and cartridges.

TECHNICAL SPECIFICATION:
Pre-amp – Output – 200mV.
Auxiliary inputs – 200mV and 750mV into 1 meg.
Mic input – 6mV into 100K. 240 volt operation.
Turntables capacity – 7", 10" or 12" records.
Rumble, wow and flutter
Rumble Better than –35dB. Wow Better than 0.2%. Flutter Better than 0.06% (Gaumont kalee meter).
Finish – Satin black mainplate with black turntable mat inlaid with brushed aluminium trim. Tonearm and controls in black and brushed aluminium.
Console size –
Unit Closed – 17¾" × 13¾" × 8¾" (approx.)
Unit Open – 35¾" × 13¾" × 4⅜" (approx.)

This disco console is ideally matched for the Reliant IV and Disco 50 or any other quality amplifier.

The unit is finished in black PVC with contrasting simulated teak edging, diamond spun control knobs with matching control panel.

Yours for only £45.00 + £3.50 P. & P.



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323 Edgware Road, London W2

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AC107	22
AC113	20
AC115	22
AC117K	32
AC122	13
AC125	19
AC126	19
AC127	20
AC128	20
AC132	16
AC134	16
AC137	16
AC141	20
AC141K	32
AC142	20
AC142K	28
AC151	17
AC154	22
AC155	22
AC156	22
AC157	27
AC165	22
AC166	22
AC167	22
AC168	27
AC169	16
AC176	22
AC177	27
AC178	31
AC179	31
AC180	22
AC180K	32
AC181	22
AC181K	32
AC187	24
AC187K	25
AC188	24
AC188K	25
ACY17	28
ACY18	22
ACY19	22
ACY20	22
ACY21	22
ACY22	18
ACY27	20
ACY28	21
ACY29	39
ACY30	31
ACY31	31
ACY34	23
ACY35	23
ACY36	31
ACY40	19
ACY41	20
ACY44	39
AD130	42
AD140	53
AD142	53
AD143	42
AD149	55
AD161	39
AD162	39

AD161 and AD162MP	75
ADT140	55
AF114	27
AF115	27
AF116	27
AF117	27
AF118	39
AF124	33
AF125	33
AF126	31
AF127	31
AF139	33
AF178	55
AF179	55
AF180	55
AF181	55
AF186	55
AF239	41
AL102	72
AL103	72
ASY26	28
ASY27	33
ASY28	28
ASY29	28
ASY50	28
ASY51	28
ASY52	28
ASY54	28
ASY55	28
ASY56	28
ASY57	28
ASY58	28
ASY73	28
ASZ21	44
BC107	9
BC108	9
BC109	9
BC113	11
BC114	17
BC115	17
BC116	17
BC117	20
BC118	11
BC119	33
BC120	88
BC125	13
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BCY72	16
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BCZ12	28
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BD124	76

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BDY20	£1·10
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BF196	16
BF197	16
BF200	50
BF222	£1.05
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BSX20	17
BSY25	17
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BSY41	31
BSY95	14
BSY95A	14
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C400	33
C407	28
C424	28
C425	55
C426	39
C428	22
C441	33
442C	33
C444	39
C450	24
MAT100	21
MAT101	22

MAT120	21
MAT121	22
MJE2955	95
MJE3055	62
MJE3440	55
MPF102	46
MPF104	41
MPF105	41
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TIP41A	73
TIP42A	88

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2S325	77
2S326	77
2S327	77
2S701	46
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40362	50

DIODES AND RECTIFIERS

AA119	9
AA120	9
AA129	9
AAY30	10
AAZ13	11
BA100	11
BA116	23
BA126	24
BA148	16
BA154	13
BA155	16
BA156	15
BA173	16
BY100	17
BY101	13
BY105	19
BY114	13

BY124	13
BY126	16
BY127	17
BY128	17
BY130	18
BY133	23
BY164	55
BYX38/30	46
BYZ10	39
BYZ11	33
BYZ12	33
BYZ13	28
BYZ16	44
BYZ17	39
BYZ18	39
BYZ19	31

CG62 (OA91Eq)	6
CG651 (OA70-OA79)	7
OA5	39
OA5 short leads	23
OA10	15
OA47	8
OA70	8
OA79	8
OA81	8
OA85	10
OA90	7
OA91	7
OA95	8

BB104 Varicap back to back 0·16

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Type No.	1	25	100+
72702	0·50	0·48	0·45
72709	0·25	0·23	0·20
72709P	0·20	0·19	0·18
72710	0·35	0·33	0·30
72741	0·30	0·29	0·28
72741C	0·28	0·27	0·26
72741P	0·30	0·29	0·28
72747	0·85	0·80	0·75
72748P	0·38	0·36	0·34
SL201C	0·59	0·45	0·40
SL701C	0·50	0·45	0·40
SL702C	0·50	0·45	0·40
TAA263	0·80	0·70	0·60
TAA293	£1·00	0·95	0·90
TAA350A	£1·85	£1·80	£1·70
μA703C	0·28	0·26	0·24
μA709C	0·20	0·19	0·18
μA711	0·35	0·33	0·30
μA712	0·35	0·33	0·30
TBA800	0·50	£1·45	£1·40
76003	£1·50	£1·45	£1·40
76023	£1·50	£1·45	£1·40
76660	0·95	0·93	0·90
6M380	£1·00	0·97	0·95
NE555	0·65	0·63	0·60
NE556	0·95	0·93	0·90
ZN414		£1·20 each	

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3015F Minitron .. .. £1·50
MAN 3M. L.E.D. 7-segment 0·127" £1·90

DTL 930 SERIES LOGIC I.C's

Type	Price 1	25	100+
BP930	15p	14p	13p
BP932	16p	15p	14p
BP933	16p	15p	14p
BP935	16p	15p	14p
BP936	16p	15p	14p
BP944	16p	15p	14p
BP945	30p	28p	25p
BP946	15p	14p	13p
BP948	30p	28p	25p
BP951	70p	65p	60p
BP962	15p	14p	13p
BP9093	45p	43p	40p
BP9094	45p	43p	40p
BP9097	45p	43p	40p
BP9099	45p	43p	40p

Devices may be mixed to qualify for quantity price. Larger quantity price on application. (DTL 930 Series only.)

VOLTAGE REGULATORS

TO3 Plastic 1·5 Amps

μA 7805/L129 5V (Equiv. to MVR5V) £1·35
μA 7812/L130 12V (Equiv. to MVR15V) £1·35
μA 7815/L131 15V (Equiv. to MVR15V) £1·35
μA7817 18V £1·35

74 Series T.T.L. I.C's

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Quantities £ p 1	£ p 25	£ p 100+
7400	0·15	0·15	0·13
7401	0·15	0·14	0·13
7402	0·15	0·14	0·13
7403	0·15	0·14	0·13
7404	0·15	0·14	0·13
7405	0·15	0·14	0·13
7406	0·39	0·34	0·31
7407	0·39	0·34	0·31
7408	0·25	0·24	0·23
7409	0·25	0·24	0·23
7410	0·15	0·14	0·13
7411	0·25	0·24	0·23
7412	0·28	0·27	0·26
7413	0·32	0·31	0·30
7416	0·30	0·29	0·28
7417	0·30	0·29	0·28
7420	0·15	0·14	0·13
7422	0·30	0·29	0·28
7423	0·40	0·39	0·38
7425	0·40	0·39	0·38
7426	0·40	0·38	0·36
7427	0·40	0·38	0·36
7428	0·45	0·42	0·40
7430	0·15	0·14	0·13
7432	0·40	0·38	0·36
7433	0·42	0·40	0·38
7437	0·35	0·32	0·30
7438	0·35	0·32	0·30
7440	0·15	0·14	0·13
7441	0·74	0·71	0·64
7442	0·74	0·71	0·64
7443	£1·20	£1·15	£1·10
7444	£1·20	£1·15	£1·10
7445	£1·60	£1·55	£1·50
7446	£1·20	£1·15	£1·10
7447	£1·10	£1·07	£1·05

Type	Quantities £ p 1	£ p 25	£ p 100+
7448	£1·10	£1·07	£1·50
7450	0·15	0·14	0·13
7451	0·15	0·14	0·13
7453	0·15	0·14	0·13
7454	0·15	0·14	0·13
7460	0·15	0·14	0·13
7470	0·32	0·29	0·27
7472	0·32	0·29	0·27
7473	0·41	0·39	0·35
7474	0·41	0·39	0·35
7475	0·60	0·58	0·56
7476	0·44	0·43	0·42
7480	0·60	0·58	0·55
7481	£1·10	£1·05	£1·00
7482	0·90	0·85	0·80
7483	£1·20	£1·15	£1·05
7484	£1·00	0·97	0·95
7485	£1·60	£1·55	£1·50
7486	0·35	0·34	0·33
7489	£4·00	£3·75	£3·50
7490	0·65	0·63	0·60
7491	£1·10	£1·05	£1·00
7492	0·74	0·71	0·64
7493	0·74	0·71	0·64
7494	0·85	0·82	0·75
7495	0·85	0·82	0·75
7496	0·96	0·93	0·86
74100	£1·50	£1·45	£1·40
74104	0·60	0·58	0·55
74105	0·60	0·58	0·55
74107	0·44	0·42	0·40
74110	0·60	0·55	0·50
74111	0·90	0·88	0·85
74118	£1·00	0·95	0·90
74119	£1·50	£1·40	£1·30
74121	0·50	0·48	0·45

Type	Quantities £ p 1	£ p 25	£ p 100+
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74123	0·75	0·73	0·70
74141	0·85	0·82	0·79
74145	£1·30	£1·25	£1·20
74150	£1·50	£1·40	£1·30
74151	£1·10	£1·05	£1·00
74153	£1·00	0·95	0·90
74154	£1·70	£1·65	£1·60
74155	£1·20	£1·15	£1·10
74156	£1·20	£1·15	£1·10
74157	£1·00	0·95	0·90
74160	£1·40	£1·35	£1·30
74161	£1·40	£1·35	£1·30
74162	£1·40	£1·35	£1·30
74163	£1·40	£1·35	£1·30
74164	£1·80	£1·75	£1·70
74165	£1·80	£1·75	£1·70
74166	£1·60	£1·55	£1·55
74174	£1·60	£1·55	£1·50
74175	£1·10	£1·05	£1·00
74176	£1·25	£1·20	£1·15
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74180	£1·25	£1·20	£1·15
74181	£3·95	£3·85	£3·75
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74194	£1·30	£1·25	£1·20
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74196	£1·20	£1·15	£1·10
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100	05	07	1N4002	06	10	17	23	75
200	06	10	1N4003	07	12	22	25	1·00
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UIC03=12×7403	0·54	UIC51=12×7451	0·54	UIC92=5×7492	0·54
UIC04=12×7404	0·54	UIC53=12×7453	0·54	UIC93=5×7493	0·54
UIC05=12×7405	0·54	UIC54=12×7454	0·54	UIC94=5×7494	0·54
UIC06=8×7406	0·54	UIC60=12×7460	0·54	UIC95=5×7495	0·54
UIC07=8×7407	0·54	UIC70=8×7470	0·54	UIC96=5×7496	0·54
UIC10=12×7410	0·54	UIC72=8×7472	0·54	UIC100=5×74100	0·54
UIC20=12×7420	0·54	UIC73=8×7473	0·54	UIC121=5×74121	0·54
UIC30=12×7430	0·54	UIC74=8×7474	0·54	UIC141=5×74141	0·54
UIC40=12×7440	0·54	UIC76=8×7476	0·54	UIC151=5×74151	0·54
UIC41=5×7441	0·54	UIC80=5×7480	0·54	UIC154=5×74154	0·54
UIC42=5×7442	0·54	UIC81=5×7481	0·54	UIC193=5×74193	0·54
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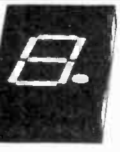

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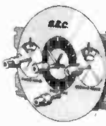

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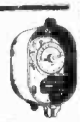

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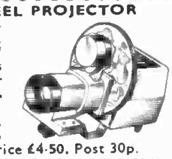

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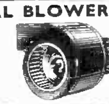

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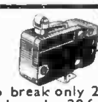

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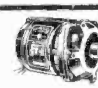

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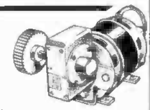

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PE

A HEALTHY MARKET

In home constructor circles the component supply position has been a major bone of contention on many occasions in the past. It is pleasing, therefore, to comment upon the greatly improved situation we are currently enjoying. Part of this general improvement in the market is due to additional retail outlets which have come into existence to serve the private constructor. In recent times more industrial distributors have taken a close and quizzical look at the home constructor field; some, certainly, have liked what they have seen and have decided to extend their operations into this market, either through an extension of their existing business organisations, or through new companies launched to deal exclusively with small-order business.

Maybe the potential trade offered by the amateur market has assumed greater importance because the industrial business, on the other hand, has lost some of its former buoyancy under present difficult economic conditions. Cynics may indeed see this as the main reason for this late conversion of some suppliers to the home constructor market. But the cause matters infinitely less than the effect produced. All conversions are very welcome and we hope more will follow.

Whatever may in fact be the state of the industrial market, it is obvious that many component distributors have at last realised that the home constructor market represents rather more than peanuts. No sensible business man can afford to turn a blind eye to an area which still shows continuing growth during what is freely admitted to be a gloomy and rather stagnant period in trading affairs. So what could be more natural than a redirection of some of the accumulated components, especially the latest semiconductor devices, towards a market where demand persists and looks like growing even more.

As well as the opening up of additional retail outlets, significant changes have come about in the kind of components now made available to the amateur, both by the long established suppliers of this market, and the newcomers. Circuit modules, for example, originally intended for the exclusive use of set manufacturers have for some time now been featured in the advertisements and catalogues of component retailers. The range of i.c.'s listed has expanded, and devices which a few years ago would have been considered "too advanced" for the amateur are now commonplace lines.

This emancipation of components owes much to the revelation of their existence through designs published in magazines such as P.E. The brusque statement "not available to the amateur market" was frequently heard in the past from sales executives of some of the larger and important component makers. This discouraging and rather haughty kind of utterance is not so commonplace today, we are delighted to say.

F.E.B.

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THE INCREASING interest in water sports, particularly sailing and power-boating, being shown these days has resulted in the development of a number of electronic devices for the boat owner. Not least amongst these is the marine speedometer with analogue readout, similar to the familiar car speedometer.

Such an instrument gives an immediate indication of the speed of water past the hull of a boat and is of use in both power and sail work for tuning and performance observations.

THE SYSTEM

In basis, a marine speedometer is made up of two parts, a transducer capable of sensing the speed of the water past the hull and a converter which changes the transducer signal into a visual indication of this speed.

Various methods have been used to sense the relative speed, including propellers, water wheels and even wands forced back against spring action. Of these the propeller type is generally favourite for a variety of reasons and the present case makes use of a commercially available skeg-mounted propeller unit manufactured by E.M.I. and readily available as a spare for the Emilog.

The pick-up system is shown in Fig. 1 from which it will be seen that the skeg mounting takes the propeller away from the hull of the boat. Whilst the distance is in fact small, only a matter of inches overall projection, it is sufficient to avoid problems due to "skin effect" adjacent to the hull where the water flow is not indicative of boat speed.

The transducer design is simple and thus reliable. A small magnet is cast in the hub of the propeller and the variation in magnetic field caused as this rotates is detected by the coil mounted inside the hull. Assuming a non-magnetic hull, this of course gives a distinct advantage to this system since the hull need not be broken at all, the skeg being mounted on the outside whilst the coil is located inboard.

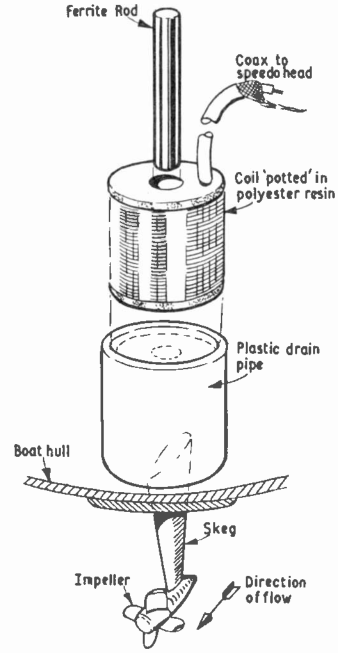


Fig. 1. The speedometer skeg and pick-up system

The rate of pulses from the coil alters in a fairly linear fashion with the boat speed and thus it is possible to carry out calibration of the electronics and indicator on the bench if required. Of course, a final check over measured distances and times would be needed for optimum accuracy.

PICKUP COIL

The coil is basically very simple, consisting of around 28g or 1oz of 40 s.w.g. copper wire wound round a 2in length of $\frac{3}{8}$in ferrite rod. The finished coil can be potted in epoxy resin in a former made up from a 2in length of 1in diameter plastic drain pipe. In this way the unit is fully protected against the vagaries of boat bilge environments.

It is advisable to use co-ax for the lead to the indicator head as the signal from the coil is small ($\simeq$ 150mV at 7 knots) and the input to the indicator sensitive.

The potting operation is fairly simple and should not require too much resin. Probably about 1oz of Araldite will suffice. As this is normally fairly stiff in consistency it is suggested that the tubes be warmed gently before use and, if still rather stiff, a few drops of methylated spirit will help the flow if mixed in during the 2-part mixing stage.

After casting, the setting process can be accelerated if this is allowed to take place in a warm environment and should take about 20 minutes to reach firmness. Twenty-four hours is required for real hardness.

Fig. 2 shows the circuit diagram of the electronics for the speedometer. The very small signal from the pickup coil is amplified by the operational amplifier IC1 and then fed to a Schmitt trigger TR1, TR2. This latter provides a square wave output with a fast rise time which is used to drive a monostable, TR3, TR4 which provides a chain of pulses of constant length and a repetition rate equal to the rotation rate of the propeller.

Finally, the pulse chain is fed to an output amplifier TR5 which drives an indicating meter ME1.

Ranges of 0 to 10 and 0 to 20 knots are obtained by selecting VR2 or VR3, R17, and S1 (not shown). S1 can be part of S2, giving off, range 1 and range 2 positions.

COMPONENTS . . .

Resistors

R1	1·5kΩ	R9	5·6kΩ
R2	12kΩ	R10	4·7kΩ
R3	3·3MΩ	R11	10kΩ
R4	3·3kΩ	R12	6·8kΩ
R5	33Ω	R13	8·2kΩ
R6	2·7kΩ	R14	10kΩ
R7	12kΩ	R15	3·3kΩ
R8	1·5kΩ	R16	3·3kΩ
		R17	390Ω

All $\frac{1}{4}$W 5%

Capacitors

C1 15μF, 40VW elect.
C2 10nF, 160VW polyester
C3 0·22μF, 250VW polyester
C4 68μF, 16VW elect.

Potentiometers

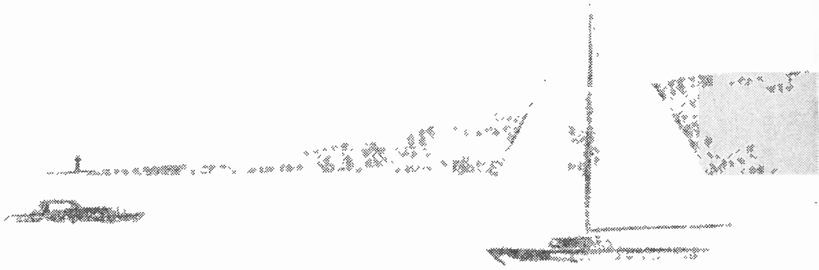
VR1 2·2kΩ skeleton preset, 0·1in matrix
VR2, 3 470Ω skeleton preset, 0·1in matrix (2 off)

Semiconductors

IC1 SN72741 (741 operational amplifier)
TR1 to 4 BC113 (4 off)
TR5 BC108
TR6 BFY51
TR7 2N1305
D1, 2 BZY88 C6V2 (2 off)

Miscellaneous

Material for pick-up coil, wire, 2in ferrite rod, Araldite etc.: Emilog impellor: suitable case or housing, preferably plastic: Veroboard, 0·1in matrix: Co-ax cable and plug/socket: 2 batteries, PP3 or PP6, 9V or alternately 2 × 1kΩ, 1W resistors: 1mA meter suitably rescaled: S1, SPCO and S2, DPCO.



SPEEDOMETER By C. GAMMONS

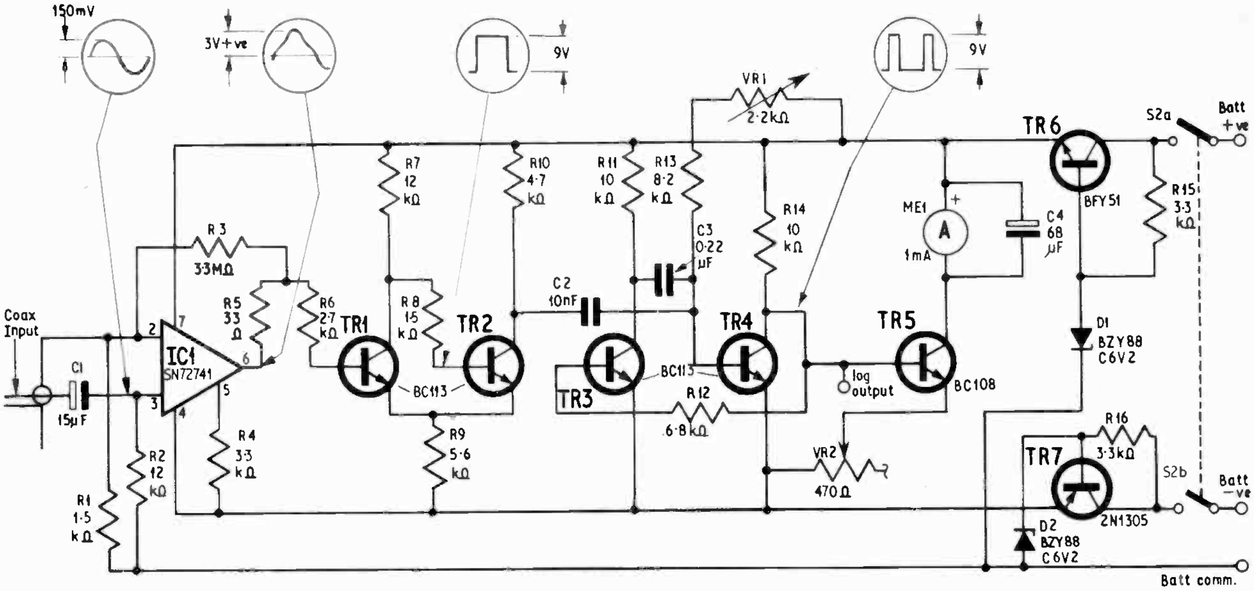
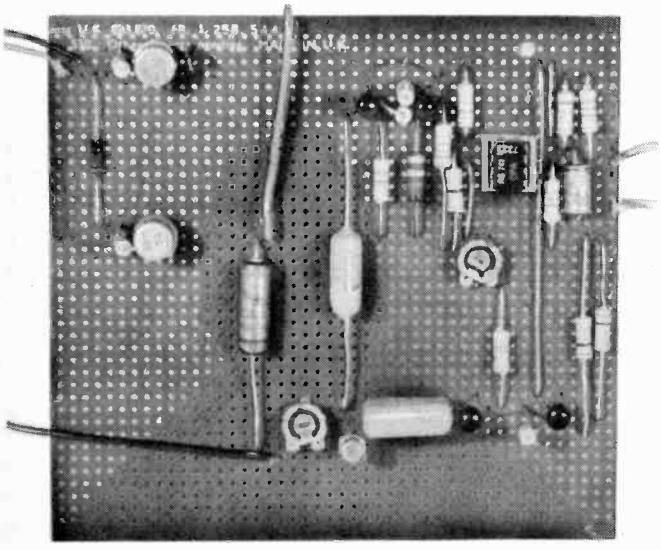


Fig. 2. Circuit diagram of the marine speedometer showing range switching

POWER SUPPLY

In the prototype the unit was powered by two PP6, 9V dry batteries, the input rails being stabilised using TR6, TR7, D1 and D2. The stabilisation circuitry should be retained with all forms of power supply for optimum results though the dry batteries may be replaced by the boat supply or some other source.

Of course, if a 12V boat supply is used it will need to be wired to give 6, 0, 6V, just as a 24V supply would be tapped to give 12, 0, 12V if this is used. In fact the centre tap can be supplied by putting two, 1kΩ 1W resistors across the full supply in series and connecting 0V to the centre point thus formed.



Veroboard component layout for the marine speedometer

CONSTRUCTION

A Veroboard cutting and component layout diagram is shown in Fig. 3. Assembly follows normal practice and it is recommended that a holder be used for the i.c.

After assembly, the completed card can be tested by connecting suitable batteries or a bench supply and feeding about 215mV of 50Hz audio signal from an a.f. oscillator (or indeed a small mains transformer with a suitable attenuator network on the output) to the input.

With such an input the meter deflection should be between $\frac{1}{3}$ and f.s.d. It should be adjusted to give a reading of $\frac{3}{4}$ f.s.d. by suitably altering VR1. In the present circuit VR2 is set to mid-position.

An alternative method of supplying the 50Hz signal is to use the pickup coil itself. This is placed next to a mains transformer so that current is induced in the coil and this in turn is used to drive the indicator circuitry.

In this way both the coil and the electronics are tested at one time although one has to be careful with respective positioning of coil and transformer due to the presence of 100Hz pickup at certain distances.

If the circuit proves to be impossible to calibrate then a wiring and full circuit check is in order and it is recommended that a reasonable 20kΩ/V meter be used for this.

The final step in calibration involves the meter scale markings. If the meter carries a 0 to 10 or 0 to 100 scale then this will suit as it stands for a 0 to 10 knot scale. If the basic scale needs alteration then the scale plate should be carefully removed from the instrument and the unneeded numerals removed with an abrasive rubber, Vim or some similar gentle compound. If care is taken the face will not be damaged and the new figures and lettering required can be put on using pressure-adhesive lettering such as Letraset.

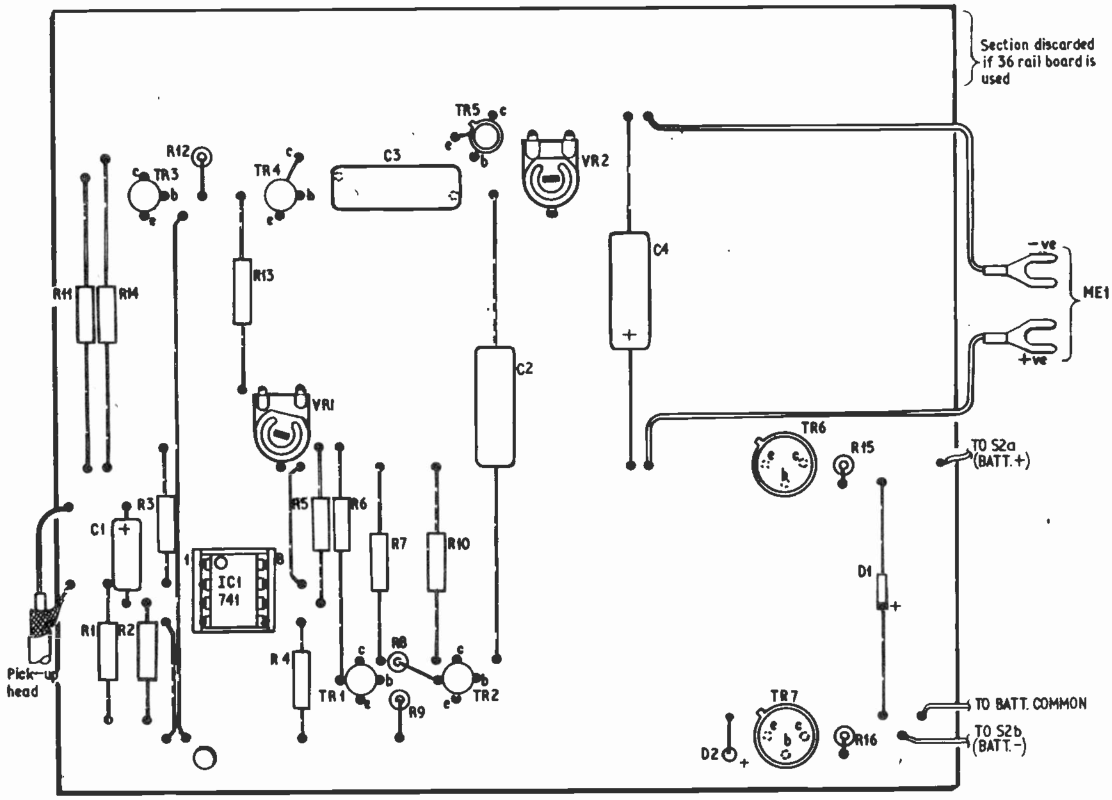


Fig. 3. Veroboard cutting and component layout for the marine speedometer of Fig. 2

The illustration of a prototype meter shows how both scales and an associated range switch may be arranged in a die-cast box.

HOUSING

There are a number of alternative methods of housing, extending from the die-cast box to some rather well-made plastic cases now available. In any case, the housing chosen should be capable of protecting the circuit board from the usually unfriendly environment of a boat.

The Emilog impeller unit can be obtained from EMI agent chandlers but in the event of difficulty contact:—EMI Marine, Cramptons Road, Sevenoaks, Kent. ★

FOR SCINTILLATING SOUND

PE ORION... HI-FI STEREO AMPLIFIER

By D.S. GIBBS & I.M. SHAW* C.Eng., M.I.E.E.

THIS month full constructional detail for the Orion will be given together with test and fault finding procedures.

COMPONENTS

An effort has been made to use standard, easily obtainable components as far as possible, most of which can be obtained through firms advertising in this magazine.

Components which require special attention are the 0·33 ohm wirewound resistors. These should be low inductance types such as the 0·33 ohm, 2·5W from R.S. Components, the Welwyn W21 3W or C.G.S. C3A 3W. No other types should be used.

CONSTRUCTION

It is best to start by assembling the printed circuit board. The layout of this is shown in Fig. 2.1. The three push-button switches should be mounted first, followed by all the resistors and capacitors. Take care with the polarity of the electrolytic and tantalum bead types. Some tantalum capacitors are now marked with the polarity, but the colour coded type are not. The polarity of these can be deduced from Fig. 2.2.

All the semiconductors can now be soldered in place. Take care to connect the E-Line transistors the right way round.

The four fixing screws for the output transistors must be nylon, and these screws also hold the heatsink to the board. The heatsink is a six inch length of heavy gauge 1in × 1in × $\frac{1}{8}$in aluminium angle. Mica washers should be used under all the output transistors and a thin smear of silicone grease or heatsink compound is beneficial in reducing the thermal resistance.

The bias transistors TR7 and TR107 are held down on to the heatsink by 6BA screws and a thin strip of metal to give good thermal contact. Care should be taken not to overtighten these screws or damage to the transistors may result. The screws should be just sufficiently tight to hold the bias transistors firmly against the heatsink, and can be locked with a blob of paint if desired. A small smear of silicone grease under the bias transistor helps in achieving good thermal contact.

Finally, all the connecting wires required should be soldered into the board, and the board checked carefully for mistakes and for solder "bridges" between adjacent tracks.

DRILLING

The main chassis should be drilled as shown in Fig. 2.3 and all the holes carefully deburred. Take special care with the three holes for the push-button switches as these need to be accurately placed and will remain visible after assembly. Errors or careless drilling will spoil the appearance of the finished amplifier.

A slight modification is necessary for the four DIN input sockets to be fitted to the back of the case. The left hand side of both the back panel and the back of the cover are removed and the hole created is filled with a 2in wide strip of aluminium sheet. This strip is clamped between the heatsink and the back of the case of the amplifier (Fig. 2.5).

LABELLING

If the drilling has been done carefully it may be possible to label the panels without any further preparation, but if scratches have appeared these should be removed by rubbing lightly with wire wool lubricated with soap and water. Rub in one direction along the length of the front and back panels until all the scratches have been removed.

The panel should then be dried and given one thin coat of protective lacquer, such as Letraset 101

* Ferranti Ltd.

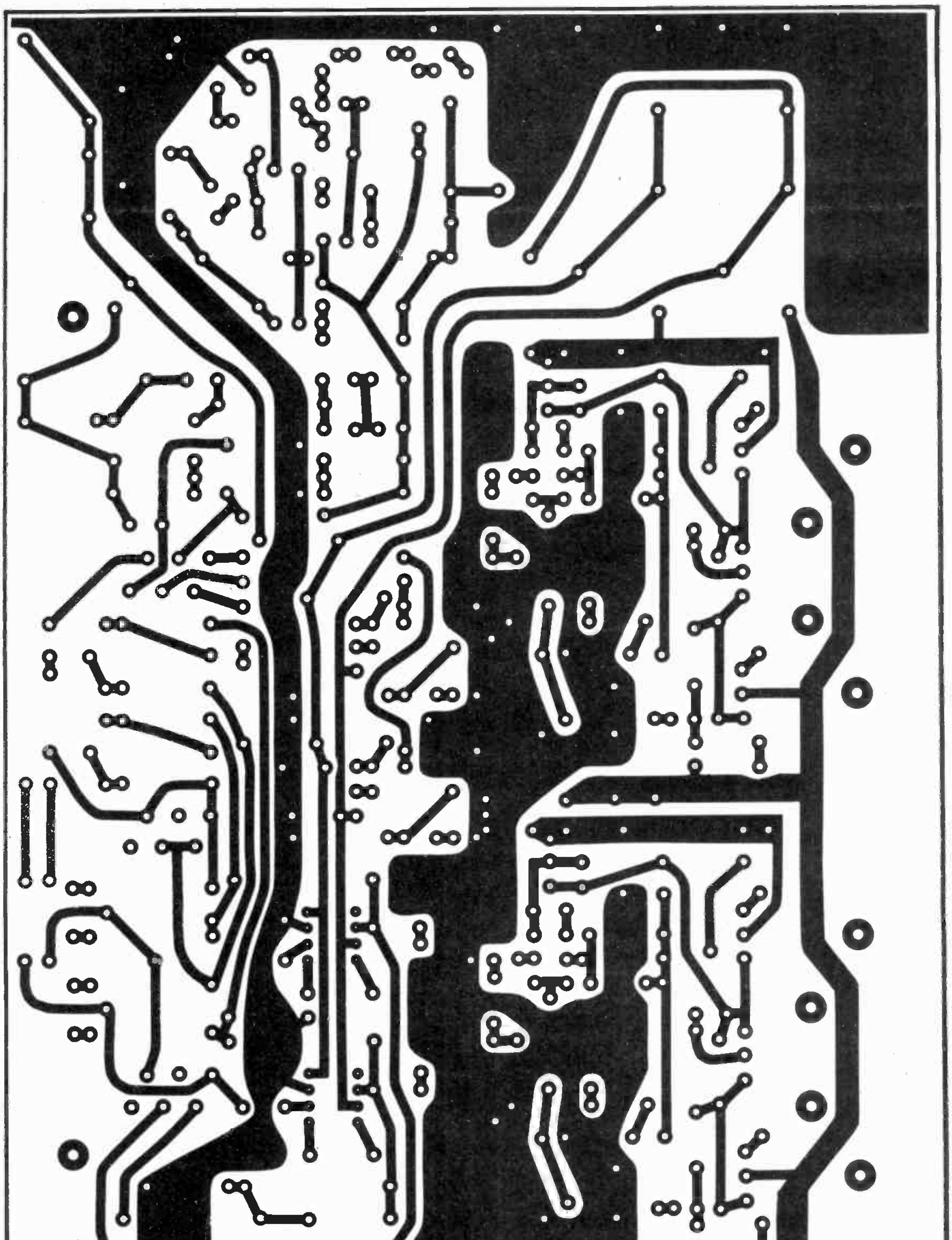


Fig. 2.1. Same size layout of printed circuit board

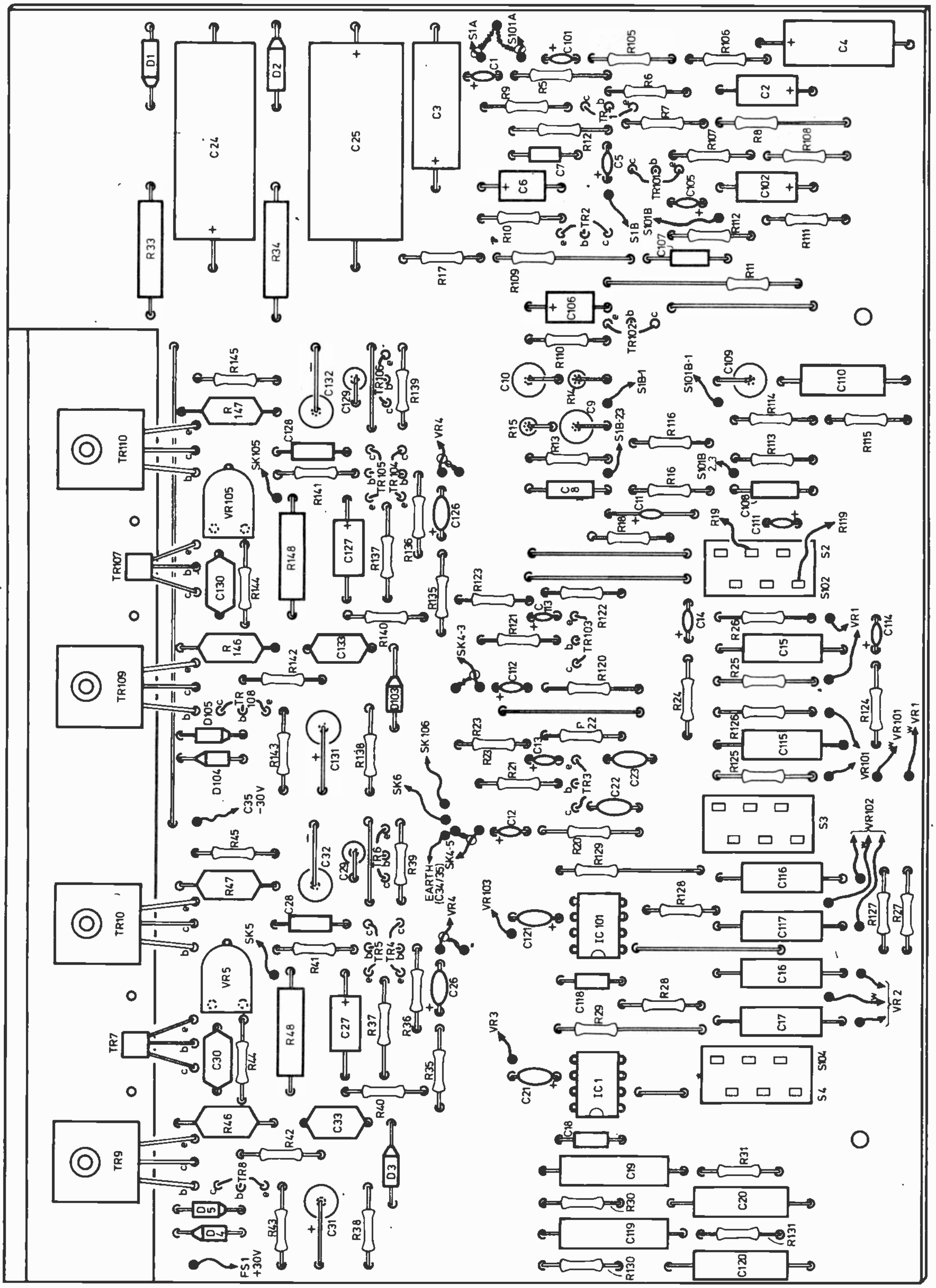


Fig. 2.2. Component layout of printed circuit board

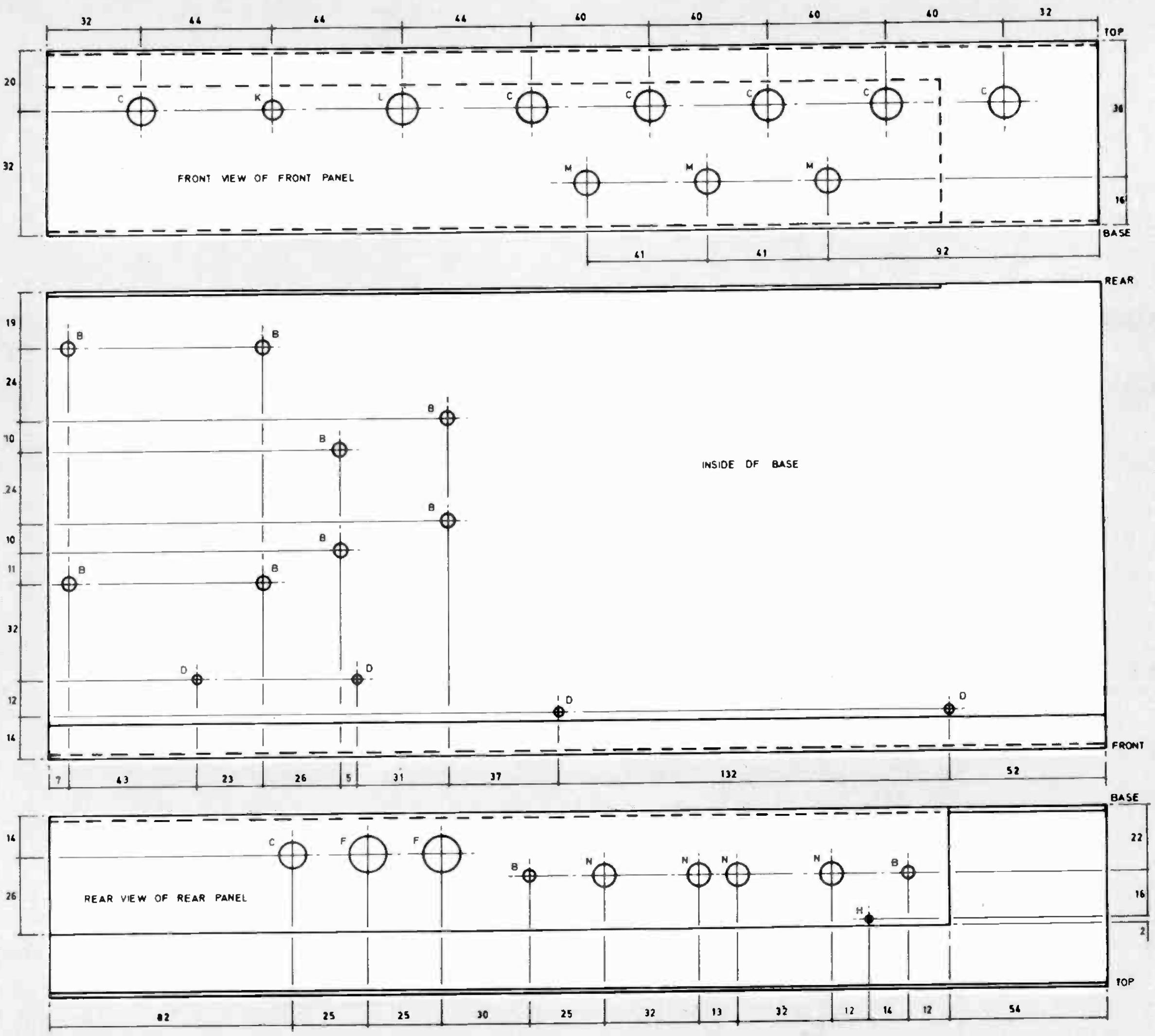


Fig. 2.3. Drilling details of main chassis

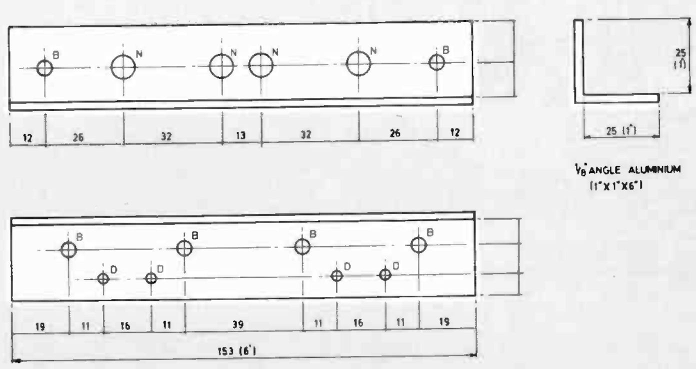


Fig. 2.4. Drilling details for the output transistor heatsink. "N" holes should be drilled using the mounting plate of Fig. 2.5 as a template

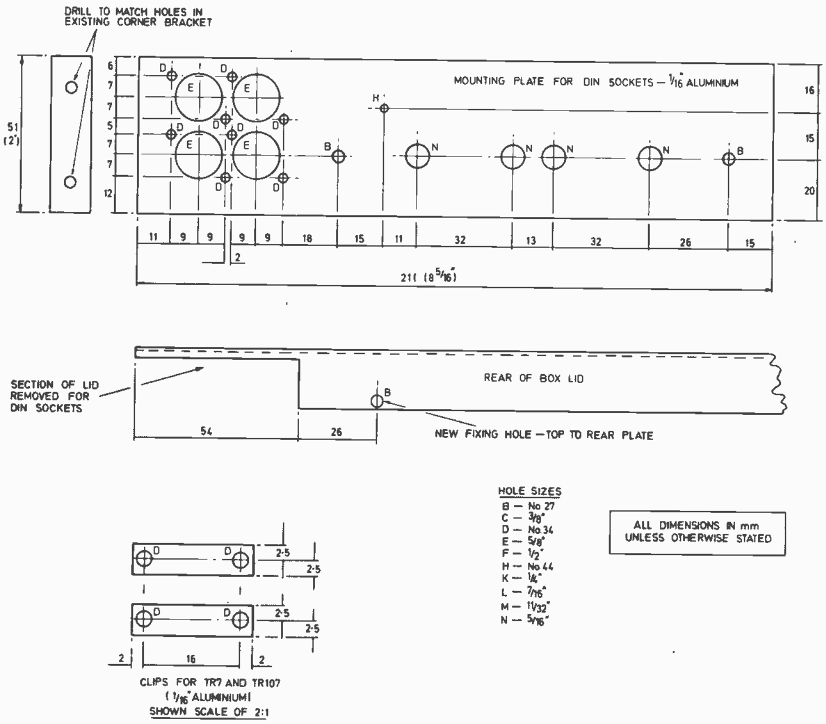


Fig. 2.5. Drilling details for DIN socket mounting plate, lid and small heat-sinks for TR7 and TR107

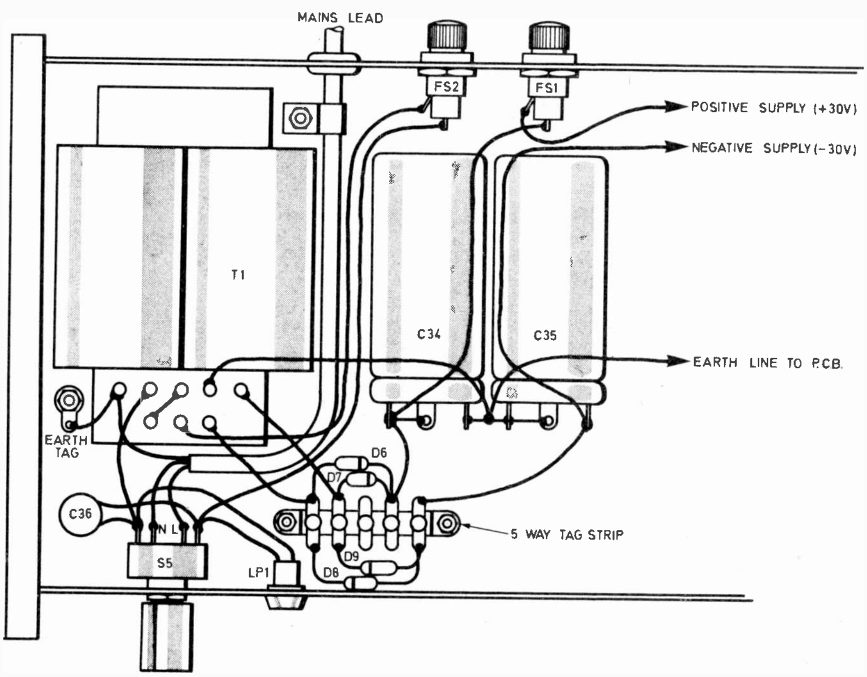


Fig. 2.6. Component layout for the power unit. The two hardwood end-cheeks are 7in × 2¼in × ⅝in

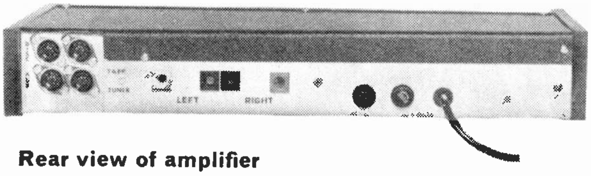
or Letracote. This gives the panel a smooth surface to which the instant lettering will adhere well. The panels can then be lettered using Letraset or some similar instant lettering. Take great care to get all the words level and evenly spaced as a little carelessness will spoil the appearance of the amplifier. After the lettering has been completed it should be sprayed with two further thin coats of protective lacquer.

CHASSIS ASSEMBLY

After the drilling has been completed and the panels lettered the wooden ends can be screwed back in place. The mains transformer should then be mounted, followed by the two fuseholders and the clamps for the smoothing capacitors.

The four rectifier diodes should be soldered to their tagstrip and mounted in place. Any suitable piece of tagstrip with five or more tags can be used and the case should be drilled to suit. The rotary mains switch and the headphone jack can then be fitted.

The complete printed circuit board is fixed in place with two ¼in spacers at the front, and by the four 4mm output sockets and two 4BA screws at the rear. Take care that the printed circuit board does not short against any of the screws in the corner of the case. If the push-button switches do not quite line up with their holes they can be bent slightly on their tags.



Rear view of amplifier

The potentiometers and the selector switch are next fitted and the wiring up commenced. Screened wire should be used between the DIN input sockets and the selector switch, between the selector switch and the input stage, to the tape inputs, and between the balance control and the main amplifier inputs, but ordinary connecting wire is satisfactory elsewhere. All leads should be as short as possible and the output and power supply leads should be kept well away from the preamplifier part of the circuit and all leads carrying low level signals.

A piece of thin insulating material should be glued inside the top cover over the terminals of the mains transformer to eliminate the possibility of the cover touching the terminals if anyone should lean on the top of the case.

TESTING

After all the constructional work has been completed, check the circuit carefully for errors, and turn the two bias potentiometers VR5 and VR105 fully anticlockwise.

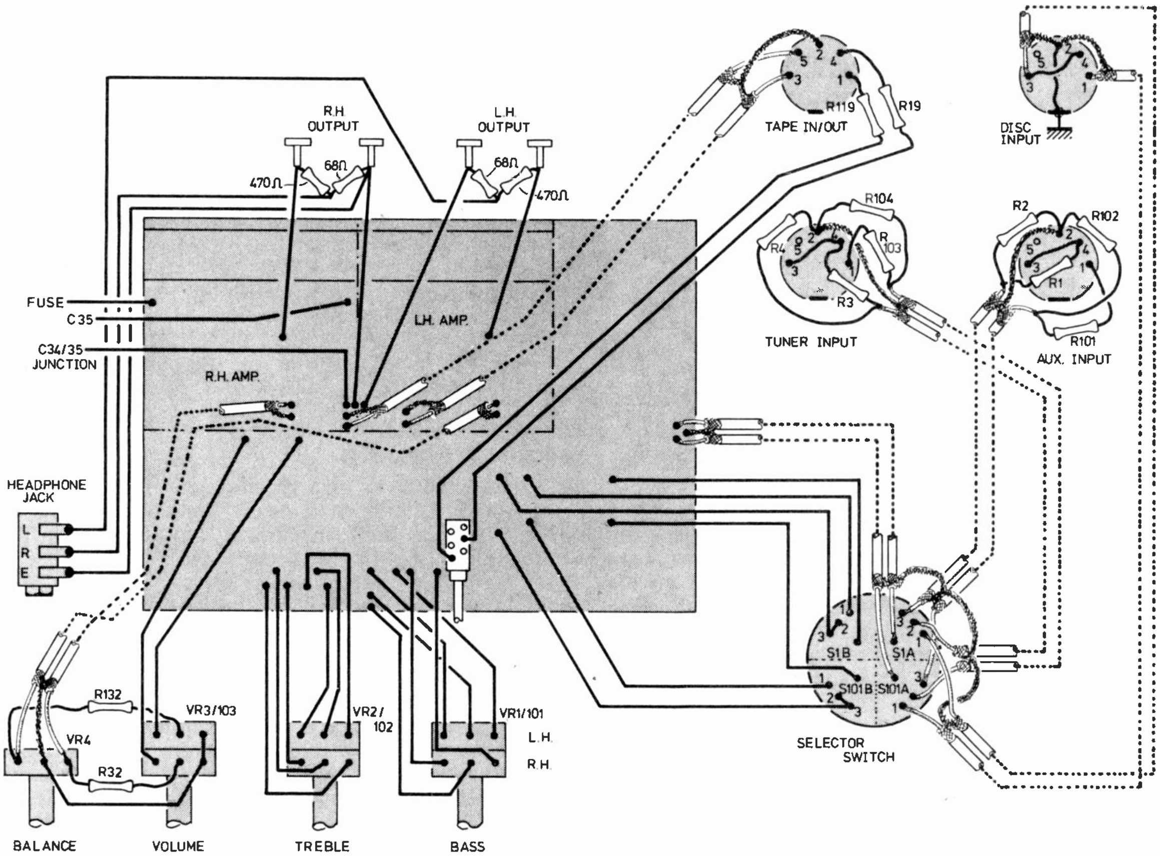
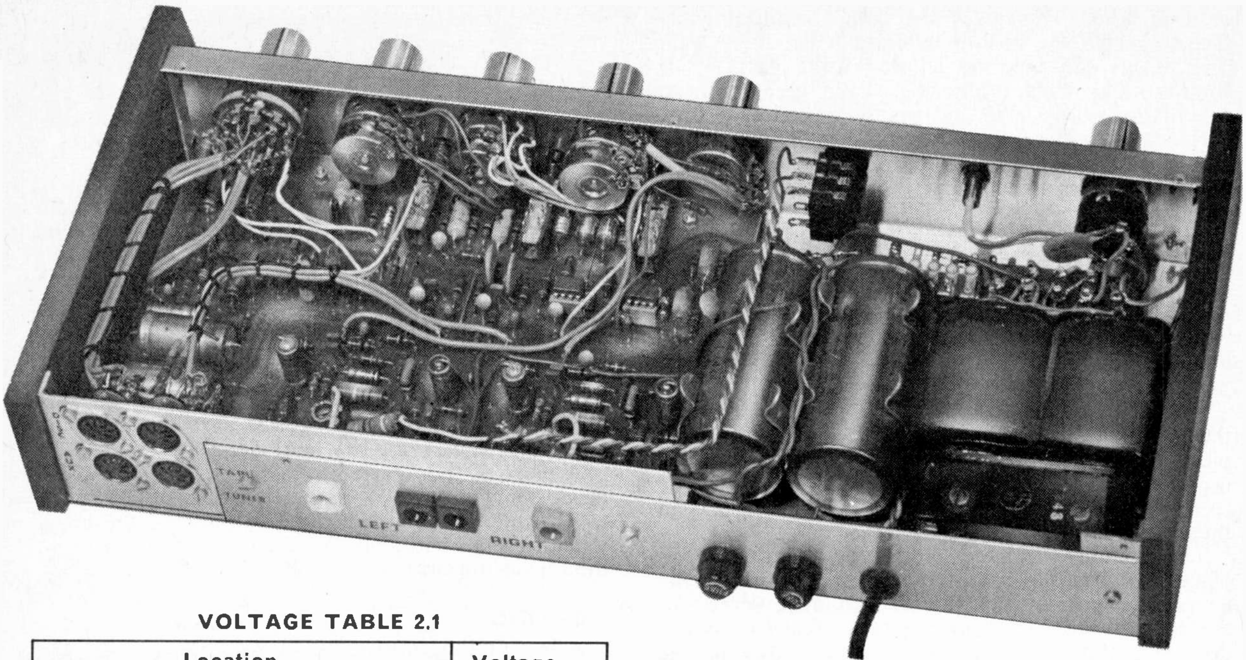


Fig. 2.7. External wiring to p.c.b.



VOLTAGE TABLE 2.1

Location	Voltage
Across D4 and D5	1·3V
Across R43	0·6V
Across R39	0·6V
TR6 collector	− 1·2V
TR8 collector	1·2V
D3 anode	12V
TR4, TR5 emitters	0·7V
D1 anode	15V
D2 cathode	−15V
IC1 (pin 6)	0V
TR3 emitter	−1·2V
TR2 collector	1V
TR2 emitter	9·2V
TR1 emitter	−0·7V
C3	14V
C4	−14V
C34	30V
C35	−30V
All voltages are measured relative to chassis with no signal input.	

The initial testing should be done with a 1A fuse (FS1) and with the speakers disconnected and the volume control set at minimum.

Connect a meter reading 0-500mA or 0-1A in the positive rail, between C34 and FS1, and switch on. The meter should read about 80mA. Now turn either VR5 or VR105 until the reading on the meter increases by about 10mA.

Leave the amplifier running for about 10 minutes and then readjust if necessary. Repeat this procedure for the other channel. Check the voltage across the output terminals of each of the amplifiers. This should be less than 0·1V.

The loudspeakers and the record player deck or tuner can now be connected and the amplifier tested on music. Fuse FS1 can be left as 1 amp if only speech and music operation is required, but it should be increased to 2 A if the amplifier is to be driven at full power of if it is to be used with a transformer load (e.g. a Quad electrostatic loudspeaker).

VOLTAGES

A table of voltages (Table 2.1) is given to assist in fault finding. Due to the unregulated power supply there may be considerable variations in some voltages due to mains voltage variations and so differences of up to 20 per cent from the values given do not necessarily indicate a fault. Voltages are measured with the volume control at minimum using a meter of at least 20,000 ohms/volt.

EARTH LOOPS

Earth loops are a common problem with audio systems, usually evident as a loud hum on both channels. They arise when two pieces of equipment, such as an amplifier and a turntable, are both connected to a mains earth. Different voltages are induced in the earth leads of the two units and this causes a 50Hz current to flow in the braid of the screened cable connecting them. The fault can be cured by removing one of the earths, preferably not the amplifier, and the other equipment is then earthed via the amplifier.

FAULT FINDING

It is difficult to give specific advice as the number of possible faults in a newly built amplifier is very large and a fault in almost any component will affect the amplifier in some way. However the following general advice can be given:

Fault on Disc/Radio. Check Disc input stage.

Fault on Tape. Check Tape input and interconnecting leads between amplifier and tape deck.

Fault on all inputs. Check tone control, main amplifiers and power supply.

If you find any dud transistors do not assume that the transistor was the only fault. Transistors can easily be destroyed as a result of a fault elsewhere in the circuit and the circuit should be checked thoroughly for wiring errors or incorrect components before replacing. Failure to do this may result in blowing up the replacements as well! ★

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2N697	0·16
2N698	0·40
2N699	0·45
2N706	0·14
2N706A	0·16
2N708	0·17
2N709	0·42
2N711	0·50
2N718	0·23
2N718A	0·28
2N720	0·50
2N721	0·55
2N914	0·22
2N916	0·28
2N918	0·32
2N929	0·30
2N1302	0·19
2N1303	0·19
2N1304	0·24
2N1305	0·24
2N1306	0·31
2N1307	0·22
2N1308	0·40
2N1309	0·36
2N1671	1·44
2N1671A	1·54
2N1671B	1·72
2N1671C	4·32
2N1711	0·45
2N1907	5·50
2N2102	0·50
2N2147	0·78
2N2148	0·94
2N2160	0·90
2N2192	0·40
2N2192A	0·40
2N2193	0·58
2N2193A	0·61
2N2194	0·73
2N2194A	0·30
2N2218A	0·22
2N2219	0·24
2N2219A	0·26
2N2220	0·25
2N2221	0·18
2N2221A	0·21
2N2222	0·20
2N2222A	0·25
2N2368	0·25
2N2369	0·37
2N2369	0·41
2N2646	0·55
2N2647	1·12
2N2904	0·22
2N2904A	0·24
2N2905	0·24
2N2905A	0·26
2N2906	0·19
2N2906A	0·21

2N2907	0·22
2N2907A	0·24
2N2924	0·14
2N2925	0·17
2N2926	
Green	0·12
Yellow	0·11
Orange	0·11
2N3053	0·25
2N3054	0·60
2N3055	0·75
2N3390	0·26
2N3391	0·23
2N3391A	0·29
2N3392	0·13
2N3393	0·13
2N3394	0·13
2N3402	0·18
2N3403	0·19
2N3440	0·59
2N3441	0·97
2N3442	1·25
2N3414	0·20
2N3415	0·21
2N3416	0·34
2N3417	0·24
2N3638	0·15
2N3638A	0·15
2N3639	0·27
2N3641	0·17
2N3702	0·12
2N3703	0·13
2N3704	0·14
2N3705	0·12
2N3706	0·09
2N3707	0·13
2N3708	0·10
2N3709	0·11
2N3710	0·12
2N3711	0·11
2N3712	0·96
2N3713	1·20
2N3714	1·33
2N3715	1·50
2N3716	1·80
2N3771	2·20
2N3772	1·80
2N3773	2·65
2N3789	2·06
2N3790	2·40
2N3791	2·35
2N3792	2·69
2N3794	0·24
2N3819	0·37
2N3820	0·64
2N3823	0·78
2N3900	0·28
2N3901	0·32
2N3903	0·24
2N3904	0·27
2N3905	0·24
2N3906	0·27
2N4036	0·63
2N4037	0·42
2N4058	0·16
2N4059	0·09
2N4060	0·11

2N4061	0·11
2N4062	0·11
2N4126	0·20
2N4289	0·34
2N4919	0·84
2N4920	0·99
2N4921	0·73
2N4922	0·84
2N4923	0·83
2N5172	0·12
2N5174	0·22
2N5175	0·26
2N5176	0·32
2N5190	0·92
2N5191	0·95
2N5192	1·24
2N5195	1·46
2N5245	0·43
2N5457	0·49
2N5458	0·45
2N5459	0·49
40361	0·48
40362	0·50
40363	0·88
40389	0·46
40394	0·56
40395	0·65
40406	0·44
40407	0·33
40498	0·50
40409	0·52
40410	0·52
40411	2·00
40414	3·55
40430	0·85
40583	0·23
40601	0·67
40602	0·46
40603	0·53
40604	0·56
40636	1·10
40669	1·00
40673	0·70
AC107	0·51
AC113	0·16
AC117	0·20
AC126	0·20
AC127	0·20
AC128	0·20
AC151V	0·25
AC152V	0·17
AC153	0·25
AC153K	0·33
AC154	0·20
AC176	0·23
AC176K	0·33
AC187K	0·23
AC188K	0·34
ACY18	0·24
ACY19	0·27
ACY20	0·22
ACY21	0·26
ACY28	0·20
ACY30	0·58
AD142	0·59
AD143	0·60
AD149V	0·58

AD150	0·63
AD161	0·45
AD162	0·45
AD161 } AD162 } PR	1·05
AF109R	0·40
AF115	0·24
AF116	0·25
AF117	0·20
AF118	0·55
AF124	0·30
AF125	0·30
AF126	0·28
AF127	0·28
AF139	0·39
AF170	0·25
AF172	0·25
AF178	0·55
AF179	0·65
AF180	0·58
AF186	0·46
AF200	0·35
AF239	0·51
AF240	0·72
AF279	0·54
AF280	0·54
AL102	0·75
AL103	0·70
BC107	0·16
BC108	0·15
BC109	0·19
BC113	0·15
BC115	0·17
BC116	0·17
BC116A	0·18
BC117	0·21
BC118	0·11
BC119	0·29
BC121	0·23
BC125	0·16
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BC141	0·29
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BC145	0·21
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BD115	0·75
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BD121	0·75
BD123	0·32
BD124	0·67
BD131	0·40
BD132	0·50

BD135	0·43
BD136	0·49
BD137	0·55
BD138	0·63
BD139	0·71
BD140	0·87
BDY20	1·05
BF115	0·25
BF116	0·23
BF117	0·43
BF119	0·58
BF121	0·25
BF123	0·27
BF125	0·25
BF152	0·20
BF153	0·21
BF154	0·20
BF158	0·23
BF159	0·27
BF160	0·23
BF161	0·42
BF163	0·32
BF166	0·32
BF167	0·21
BF173	0·24
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BF178	0·35
BF179	0·43
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BF195	0·12
BF196	0·13
BF197	0·15
BF198	0·18
BF199	0·18
BF200	0·40
BF225J	0·19
BF237	0·22
BF238	0·22
BF244	0·21
BF245	0·33
BF246	0·58
BF247	0·49
BF254	6·16
BF255	0·17
BF257	0·46
BF258	0·59
BF259	0·55
BFS21A	2·30
BFS28	0·92
BFS61	0·27
BFS98	0·25
BFX29	0·30
BFX30	0·27
BFX44	0·33
BFX63	2·48
BFX68	0·30
BFX84	0·24
BFX85	0·30
BFX87	0·28
BFX88	0·25
BFX89	0·45
BFY18	0·52

BFY19	0·62
BFY20	0·50
BFY29	0·40
BFY50	0·23
BFY51	0·23
BFY52	0·21
BFY53	0·18
BFY90	0·75
BRY39	0·23
BU104	2·00
BU105	2·25
C106A	0·48
C106B	0·55
C106D	0·65
C106E	0·43
CA3020A	1·80
CA3046	0·70
CA3048	2·11
CA3089E	1·96
CA3090Q	4·23
CD4000	0·51
CD4001	0·51
CD4002	0·51
CD4009	1·07
CD4010	1·07
CD4011	0·51
CD4015	2·66
CD4016	1·02
CD4017	2·66
CD4020	2·96
CD4023	0·51
CD4024	1·90
CD4027	1·58
CD4028	2·34
CD4029	3·79
CD4041	2·11
CD4044	2·11
CD4047	1·65
CD4049	0·90
CD4050	0·90
LM301A	0·48
LM304A	2·03
LM309K	1·88
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8DIL	0·38
14DIL	0·40
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MJ480	0·90
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MJ490	0·98
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MJE2955	1·12
MJE3055	0·68
MP8111	0·32
MP8112	0·40
MP8113	0·47
MPF102	0·39
MPSA05	0·25
MPSA06	0·26
MPSA55	0·26
MPSA56	0·27
NE555V	0·70
NE560	4·48
NE561	4·80
NE565A	4·48
OC23	1·35
OC28	0·76
OC35	0·60
OC42	0·50
OC45	0·32
OC71	0·20
OC72	0·25
OC81	0·25
OC83	0·24
ORP12	0·55
R53	1·20
RL54	0·15
SC35D	1·68
SC36D	1·46
SC40D	1·89
SC41D	1·32
SC45D	1·89
SC45D	1·96
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SL414A	1·80
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TAA263	1·00
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TAD100	1·50
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TBA800	1·50
TBA810	1·50
TIL209	0·30
TIP29A	0·49
TIP30A	0·58
TIP31A	0·62
TIP32A	0·74
TIP33A	1·01
TIP34A	1·51
TIP35A	2·09
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SN7410	0·16
SN7411	0·25
SN7412	0·28
SN7413	0·50
SN7416	0·45
SN7417	0·30
SN7420	0·16
SN7423	0·37
SN7425	0·37
SN7427	0·45
SN7430	0·16
SN7432	0·45
SN7437	0·35
SN7438	0·35
SN7440	0·16
SN7441	0·85
SN7442	0·85
SN7445	1·59
SN7446	2·00
SN7447	1·30
SN7448	1·50
SN7450	0·16
SN7451	0·16
SN7453	0·16
SN7454	0·16
SN7460	0·16
SN7470	0·30
SN7472	0·38
SN7473	0·44
SN7474	0·48
SN7475	0·59
SN7476	0·45
SN7480	0·75
SN7481	1·25
SN7482	0·87
SN7483	1·20
SN7484	0·95
SN7485	1·58
SN7486	0·45
SN7490	0·65
SN7491	1·10
SN7492	0·75
SN7493	0·65
SN7494	0·85
SN7495	0·80
SN7496	1·00
SN74100	2.18
SN74107	0·43
SN74118	1·00
SN74119	1·92
SN74121	0·57
SN74122	0·80
SN74123	0·72
SN74141	1·00
SN74145	1·44
SN74150	1·44
SN74151	1·10
SN74153	1·09
SN74154	1·66
SN74155	1·55
SN74157	1·09
SN74160	1·58
SN74161	1·58
SN74162	1·58
SN74164	2·01
SN74165	2·01
SN74167	4·10
SN74174	1·80
SN74175	1·29
SN74176	1·44
SN64180	1·44
SN74181	5·18
SN74190	1·95
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BY FRANK W. HYDE

LIFE SUPPORT SYSTEMS

The U.S.S.R. have always concentrated considerable thought on the value of life cycle support systems for space expeditions of the future. They have put such thinking to the test on a number of occasions, with remarkable success.

Two such experiments stand out from others. One of these was the experiment in which three astronauts were sealed in a chamber, which simulated a space cabin, for a year. This experiment added considerably to the data on reaction to such a closed environment.

The second outstanding piece of research was carried out, using four astronauts on a special recycling life support system, for six months. These men were again in a closed cabin simulating a space vehicle. For the duration of the experiment they were sealed in with an artificial atmosphere - created by chlorella with some additional higher plants. Much was learned from this venture, all of it very much what future planners need to know when setting up missions for the future.

The latest experiment carried out at the Institute of Medical-Biological Problems, lasted for one month with one astronaut sealed in a small cabin containing 4·5 cubic metres of air. This is some 20 times less than the volume of air available to each astronaut in *Skylab*. The main supply for the support system came from a reactor in the form of a 30 litre cylinder. This reactor contained chlorella at a very high density, some 800 to 900 million cells per cubic centimetre of nutrient fluid. Ultra-violet light was used to illuminate the reactor.

During the experiment the chlorella, with the help of microbe mineralisers to break down the urea, renewed both the oxygen and the water in the cabin. Total self regulation was not possible because the carbon dioxide and the oxygen have different gas exchange coefficients. The experimenters were a little apprehensive about the fact that two of the resultant impurities methane and carbon monoxide might reach a dangerous level in the cabin. However, this fear was not realised as the accumulation of the carbon monoxide lasted only three days and then ceased, while the methane reached an equilibrium level after some 12 days.

Because of the imbalance of the oxygen and carbon dioxide a chemical absorber to deal with excess of carbon dioxide was needed. The exchange between the human being and the chlorella production means that for every litre of carbon dioxide that the astronaut exhales, the system gives 1·2 litres of oxygen. Oxygen equilibrium if maintained gives rise to a surplus of carbon dioxide. Future systems will be arranged so that the equilibrium provided will make absorbers unnecessary.

An unpalatable part of the diet that Nikolai Mikhailov, the astronaut who was sealed in the cabin, had to suffer was to eat daily 50 grammes by weight of chlorella. However, it was laced with more palatable and homely food and no doubt this will be taken into account in future planning.

A BLACK HOLE OR NOT A BLACK HOLE

The *Uhuru* satellite discovered the X-ray source known as Cygnus X-1. The star, catalogue number HDE226868, is a bright hot star. The X-rays come from an invisible twin and not from the star itself. It was thought that matter was streaming from the bright star into the dark companion. On this supposition the dark companion was labelled a possible "black hole". This theory was tenable on the basis of the distance between the two bodies.

Now, however, new evidence has been put forward that this distance may not be as certain as was thought. A factor of two would be sufficient to reduce the candidate for black hole status to a possible red dwarf. The distance is uncertain because of the intervening dust. This is also patchy making it difficult to make a positive measurement. The further away the object is the more likely it is for the obscuring dust to make separation distance appear smaller than it is.

Support has now come for the possibility of the black hole being confirmed from three sources. These groups have results which correlate. The data comes from the Copernicus satellite and the orbiting satellite *OSO-7*. There are three groups with K. Mason, F. Hawkins and P. Sandford of the Mullard Space Science Laboratory of University College, Paul Murdin and Ann Savage of the Royal Greenwich Observatory handling the Copernicus data and Fuk Kwok Li with G. Clark handling the *OSO-7* data.

They each confirm that the dips observed in the scans of the streams going towards the dark member of the binary are variations of the X-ray source and suggest that the variations are predictable as to time. If this is the case then it may well show "black hole or no black hole".

LUNAR ROCKS AND MAGNETISM

Most workers support the view that the remanent magnetism in the Lunar rocks implies that at some time in the past a global dipole magnetic field existed on the moon of at least a thousand gammas. What is still unresolved is where the field came from in the first instance.

Apart from the possibility of a solar field which no longer exists the source could be that there was a very large galactic field at the time when the solar system was born. The Moon could have had an enhanced magnetic field because of its close proximity to the earth during this time.

It is possible that there was a phase when the Sun ejected matter at a prodigious rate and created a cyclonic type of solar wind which heated and magnetised the lunar crust. Unfortunately a close examination of the solar wind particle tracks does not support this view. Indeed there was nothing to show that the solar wind was very different from what it is now.

Again there is a dissenting view of this attitude based on the fact that most rocks analysed have been on the surface for about five million years only; this is a short spell. However, if more rock from much lower levels could be checked there might be a more positive answer. So far the lunar regolith or top soil does show evidence of a higher intensity of solar wind in the past.

Some of the more exotic theories are challenged by the findings of *Mariner 10* in regard to Mercury. The instruments detected a bow shock wave similar to that of the Earth's magnetosphere when it encounters the solar wind. When *Mariner 10* made its closest approach of 730 kilometres it detected a magnetic field of 98 gammas. This certainly implies that the surface magnetism of Mercury is of the order of 100 to 2.000 gammas. This would be more than sufficient to divert the solar wind and cause the bow shock wave.

CEEFAX AND ORACLE

A PROPOSED NEW BROADCASTING SERVICE

BY J. SMITH

MANY readers will no doubt have seen the press announcements that the BBC and IBA have agreed to a common standard for the transmission of data with the television picture. BBC's Ceefax (see the facts) and IBA's Oracle (Optical Reception of Announcements by Coded Line Electronics) are methods of transmitting written information simultaneously with the picture transmission. This written information can only be seen by viewers having special equipment to capture and decode the data.

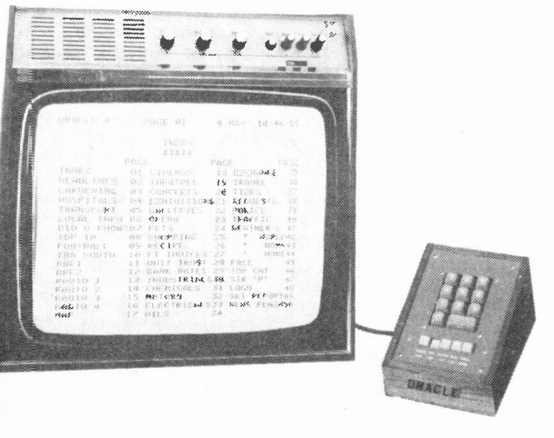
THE PRESENT SITUATION

The idea of broadcasting data signals to send written information has been discussed by engineers since the 1930's. Unfortunately the cost of facsimile equipment, together with the need to load the machine with paper and ink, has prevented this idea from getting off the ground.

Today most people have television in their homes which, together with the broadcast signal, provide the means to receive and display written information. No messy inks or rolls of paper, just the familiar TV set and a new unit to receive and decode the data signals.

At the present time the decoding units are not cheap (they are not even available), but would cost well over a hundred pounds. A dedicated amateur could build one for a hundred pounds or so, but remember the transmissions are experimental for the present. For the future, when one considers how the cost of an electronic calculator has fallen from over £1,000 to under £30, there is every hope that these decoder units can be brought down to the same level.

A TV set displaying an Oracle index page. The small unit is the decoder



OVERALL SYSTEM

The system envisaged will allow the viewer to select up to 100 "pages" of information and display each page on his TV receiver. Each page will consist of 24 rows with 40 characters per row including spaces, about 150 to 200 words per page. This is of course a very low word density, four or five pages being necessary to give as much information as one page in PRACTICAL ELECTRONICS.

Obviously such a system cannot for a variety of reasons replace a daily newspaper, especially if you want to read it on the train, but it will be an additional public information service. For example, the TV pages will contain such information as an index, a list of programmes on television and radio, news flashes, weather forecasts, sub-titles for the deaf, sporting news, traffic conditions, financial news, statistics and graphs to supplement economic programmes and even local events of general interest in the service area.

In operation the viewer will have a small keyboard which will enable him to select any one of the 100 pages by pushing the appropriate buttons. He first selects the index page to see what information is available. Having decided he wishes to examine page 22 for example, he pushes buttons 22 and waits for up to 15 seconds, normally less, when the information is displayed on his television screen. The information is displayed for as long as the viewer wishes and only erased when he selects another page or returns to normal viewing.

DATA TRANSMISSION

The data are transmitted on two unused lines during the frame blanking period of the UHF (625 line) system. The data can be seen by adjusting picture height control until the frame blanking period is visible. The data consist of little black and white dots running along the top of the picture.

The service will not be available in fringe areas because it is in the nature of digital signals to suffer rapid impairment as the signal strength weakens.

HOW DOES IT ALL WORK?

At the present time the system makes use of lines 17 and 18 (lines 330 and 331 on the interlace scan), that is two lines of data transmitted in every frame. Other lines could be used, 13 and 14 for instance, but these have been found to interfere with some existing receivers. In the future, alternative or additional lines may be brought into use.

Fig. 1.1 shows how the data is fitted into the line period. The data blocks contain synchronisation pulses, a starting code and the address of each line, in addition to the actual data. Each line contains a complete row of 40 characters.

As each "page" contains 24 rows, a page takes 12 fields or 12/50 seconds to transmit. This is four pages a second, so a "magazine" of 60 pages takes approximately 15 seconds.

The receiving equipment stores one page only, so this transmission rate determines that a wait of up to 15 seconds is necessary, with the initial 60 page service, before receiving a selected page.

One novel feature of the system is the use of command codes in the naturally occurring spaces between words. Whenever a command code is recognised it is automatically displayed as a space.

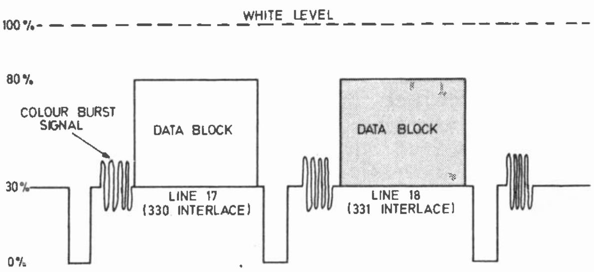


Fig. 1.1. Data is transmitted on lines 17, 18, 330, 331 and this diagram shows how the data is inserted into the video signal

INCORPORATION INTO EXISTING RECEIVERS

Fig. 1.2 shows how the overall system fits together with a unit incorporated into a television receiver.

The video and synchronisation signals are fed via a mixing unit which enables the viewer to select picture, text, or a mixture of the two. A page number is selected on the page selector and stored in a register. Signals fed into the data selector are compared with the register to find the page selected.

When the signals identical to the selected page occur they are fed to the RAM (Random Access Memory) where they are stored according to their line address. The RAM is filled under the control of the RAM control unit.

Once the RAM is full of data it is like any other memory unit and could be used to feed information to any suitable printer. For example, given the appropriate circuits the information could be fed to an electric typewriter.

The RAM can be visualised as a large matrix having rows and columns of data as shown in Fig. 1.3. Row A represents the first line of 40 characters. To obtain the first character in the line

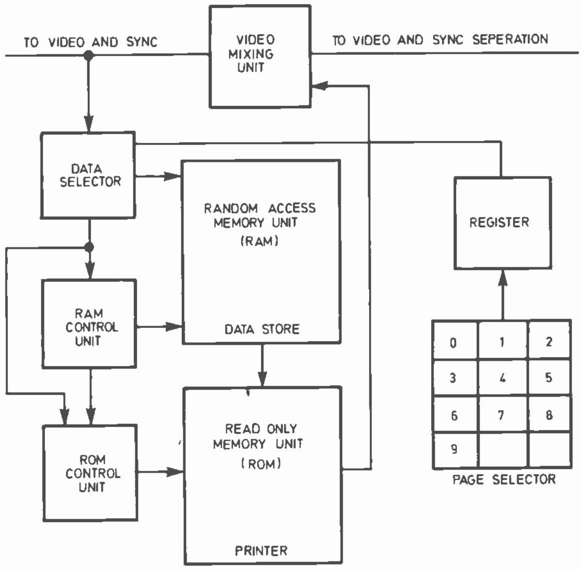


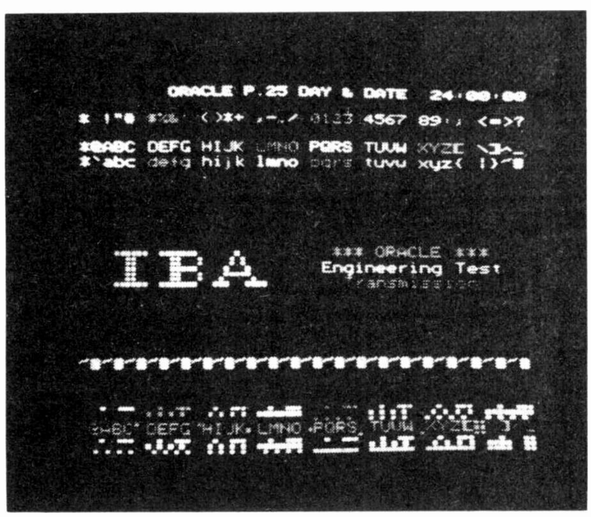
Fig. 1.2. The basic Ceefax/Oracle system

you address the memory A1 and get out the eight-bit character stored in box A1. The second character is in box A2 and so on. If the memory is addressed in sequence and each character fed to a typewriter, a line of print can be reproduced.

The memory unit has only sufficient capacity to store the contents of one page, which explains why you have to wait up to 15 seconds before you get the next page. This is the time which may elapse before receipt of the next full page of information.

If the television companies used more lines of data they could have a magazine larger than 60 pages and still take no longer than 15 seconds to produce another page. In practice it is most unlikely that a page selected will have just been transmitted; so on most occasions the RAM will be refilled with a new page in about 7·5 seconds.

An Oracle test card. Many of the characters are in colour



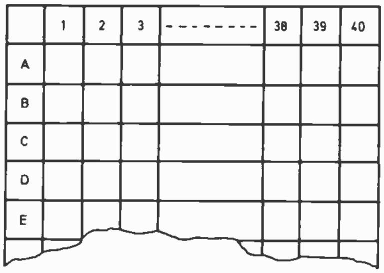
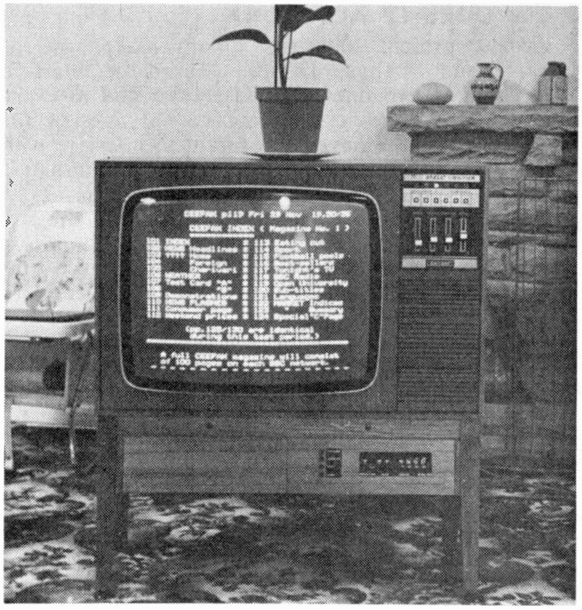


Fig. 1.3. Simplified RAM organisation. In the overall system the RAM is used to store a single page of data

Fig. 1.4. Characters contained in a Read Only Memory (ROM) designed by Mullard Ltd.

(Reproduced from Technical Note 7, Mullard Ltd., October 1974, TP1404)



A TV set with an integral decoder

(Courtesy GEC Hirst Research Centre)

CHARACTER GENERATOR

Of course Ceefax and Oracle do not employ an electric typewriter; they use the television screen, therefore a *character generator* is necessary. When the data are read out of the RAM the information is not lost; they can be read out repeatedly. This means that each frame of the TV can read the memory and display it on the screen giving an apparently "frozen" display of the page of data. All that is needed is a character generator to display characters on the TV screen. This is the function of the ROM (Read Only Memory). The characters are stored *permanently* in the ROM and organised into addresses in the same manner as data are stored in the RAM. Fig. 1.4 shows the characters contained in a ROM designed by Mullard Ltd. The addresses are given in binary notation.

To access capital A for example, the ROM is addressed with 0001 and 100. To display the characters the data in the RAM are accessed to find out which character is to be displayed. This character addresses the ROM which, together with the ROM control circuits, display the specified character on the TV screen.

This sequence of events occurs every frame so that characters are flashed onto the screen at a rate of 50 times per second for as long as the data are held in the memory. The characters are spread over a number of raster lines, the precise number being defined in the receiver design. It is expected that 20 lines will be used for each row, with characters 14 lines high and six lines between each row of characters. As the specification is still somewhat tentative, receiver manufacturers have been asked to make the ROM a plug-in unit on their experimental receivers.

In next month's article we shall look at the ROM organisation in a little more detail together with the means adopted to ensure accuracy in the received signals

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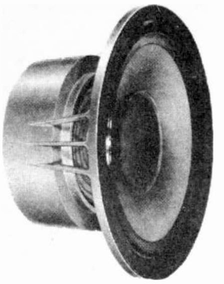

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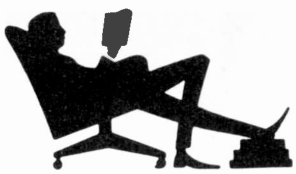

BOOK REVIEWS

ELEMENTS OF TRANSISTOR PULSE CIRCUITS (2nd Edition)

By T. D. Towers
Published by Newnes-Butterworths
198 pages, 22cm × 13cm. Price £3·50

BASED on a series of articles which first appeared in *Wireless World* in 1964, this book provides the student or engineer with an excellent introduction to bipolar transistor switching circuits.

It could be thought that nowadays the logic designer simply needs to put together a number of integrated circuits and all his problems will be solved, but sooner or later, a situation arises where it becomes necessary to return to fundamentals, either because the integrated circuits do not fulfill all requirements, thus necessitating discrete component additions to the circuitry, or because a thorough understanding of the working of the integrated circuits themselves is needed to apply them efficiently to the job in hand.

Both the principles of transistor switching circuits and simple building blocks are described in terms suitable for the engineer or student who has a basic knowledge of electronics and the mathematics of transistor operation. Very basic logic systems are described but there is no attempt to delve deeply into this area.

It is a pity that the book could not be expanded to include integrated circuit logic systems such as TTL since these are the transistor pulse circuits the designer is most likely to encounter, but even so the book gives enough guidance for the engineer to cope with these circuits with little extra information.

S.R.L.

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THESE two volumes, each over 500 pages in length, constitute a massive directory of answers to the age-old questions about machines and technology. Covering every possible facet of applied engineering from scientific measurement through the operation of T.V. to cars, tanks and guns, these volumes will provide an endless source of interest to the enquiring mind.

Hundreds of illustrations, many in two-colour, provide for ease of understanding and whilst it could be said that some are a little small or perhaps not quite as detailed as an expert in the subject might require, they provide ample clarification of each subject to give a clear understanding of the principles involved.

It is probably no exaggeration to say that these volumes will find a useful place in any home, office, workshop and school as a swift reference source to the answers for those difficult questions on operation which face us all in today's technological age.

R.D.R.

NEWS BRIEFS

Colour TV Certificate

IN response to demands from trade and industry a new Certificate of Competence in colour television servicing has been launched by the Radio, Television and Electronics Examination Board. Up until now there have been practical tests available in radio and TV servicing but nothing in colour.

The introduction of this certificate will, it is hoped, provide a national standard of practical ability which should reflect in good servicing for the consumer.

The examination is initially restricted to trained and experienced staff who hold a recognised technical qualification and who have had a minimum of one year's full time gainful experience.

Each examined candidate is required to trace a total of five faults in two hours on different chassis. An additional half-hour is allowed for adjustment of preset controls.

In addition to the practical assessment a short written test concerned with servicing matters is included.

First examinations are expected to start in March 1975. Besides the award of a certificate the Board will issue a personal identity card.

Further information can be obtained from RTEEB, Faraday House, 8-10 Charing Cross Road, London, WC2H 0HP.

Electronic Watch Displays

THE latest addition to the Litronix range of products for electronic watches is a group of four-digit displays using l.e.d.s. The complete displays are mounted on a tiny 0·75in × 0·21in ceramic substrate and all versions include a hyphen between the second and third digits.

Of the four versions available, three are full four-digit whilst one is a 3½-digit type. To reduce space requirements the packages are provided with solder bump contacts designed for reflow soldering attachment to watch modules.

Current pricing is only known for large quantities, 1,000 and upwards, at which it is £3·66 per item, but it seems clear that the costings on electronic watches are dropping fast.

Third Motorola Price Cut

YET again we are able to announce a further price cut in the Motorola CMOS range. This is the third cut in under twelve months and is said to be due to improved production techniques which have not only reduced costs but have also increased yields.

The new structure starts at 23·8 pence for a basic 14000-series quad NOR/NAND gate in quantities of 100 or more. The versatile 12-bit binary counter MC14040 has been reduced to £1·21.

It will be remembered that Motorola make most of the products for their European customers in Britain at East Kilbride. One of the factors said to be contributory in the price reductions is the fact that all production plant, including East Kilbride, use 3in diameter wafers, giving greater productivity.

PE MINISONIC

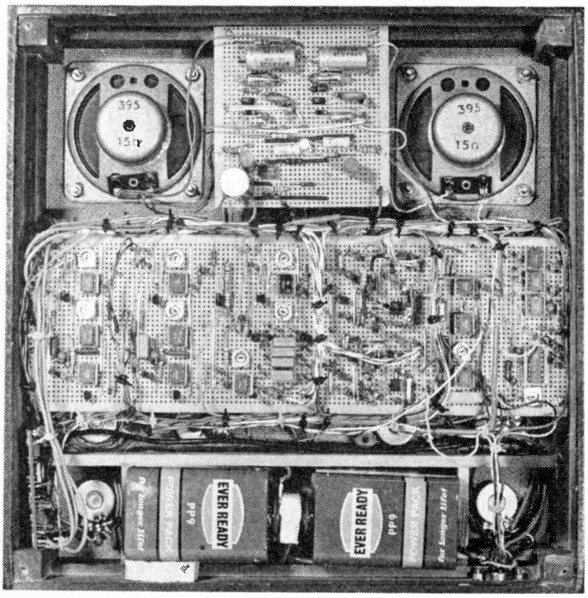
By G. D. SHAW

PART FOUR

● Final Wiring and Setting Up
● Alternative Keyboards
● Optional Extras

LAST month the electronics on the two Veroboard panels were described and so this month it only remains to connect the two boards with the controls on the front panel.

Many of our more ambitious constructors may wish to add their own conventional keyboards to the Minisonic thus making it into a more "playable" musical instrument. Four different keyboard options are therefore described.



The upper board has been extended since the photo was taken so the large board must be mounted so that its lower edge is flush with the top of the battery compartment

WIRING UP

Fig. 4.1. shows a diagram of the reverse side of the front panel. Controls have been grouped together by labelled boxes so as to indicate which part of the main Veroboard panels they are connected with. All interwiring on the front panel has been shown; interconnections from the front panel to the Veroboards are indicated by lettered designations which correspond with the letters on the Veropins on the Veroboard panels.

When wiring the main circuit board to the front panel it is preferable that the front panel be fitted into the case with all leads, equal in length to the diagonal of the case, attached.

The leads, which should be suitably colour coded, are bunch tied in groups and, ideally, should be wired to the circuit board from one side only. This will enable access to the underside of the circuit board in the event of problems.

After trimming the various leads to length they can be soldered to their respective pins and then tied off to form a neat harness.

No problems of signal induction were experienced with the prototype despite the fact that both signal and control leads were included within the same harness. The NOISE GENERATOR may possibly give rise to induced noise and for this reason the output lead to its volume control should be kept as short as possible and routed clear of other signal leads. When the NOISE GENERATOR is not in use its volume control should be kept at zero.

A DIN socket was mentioned in passing in Part 3 without any detailed description of its function. In fact its purpose is to enable external keyboards to be plugged in to the Minisonic.

Wiring to the DIN socket is shown in Fig. 4.2. The DIN socket is in fact mounted on the front wooden panel at the lower left-hand side and can be seen in the photographs.

The two Veroboard panels are mounted on the Minisonic as shown in the photograph, though the smaller panel has been enlarged somewhat thus necessitating the lowering of the larger board so that its lower edge comes flush with the top of the battery compartment.

FRONT PANEL INTERWIRING

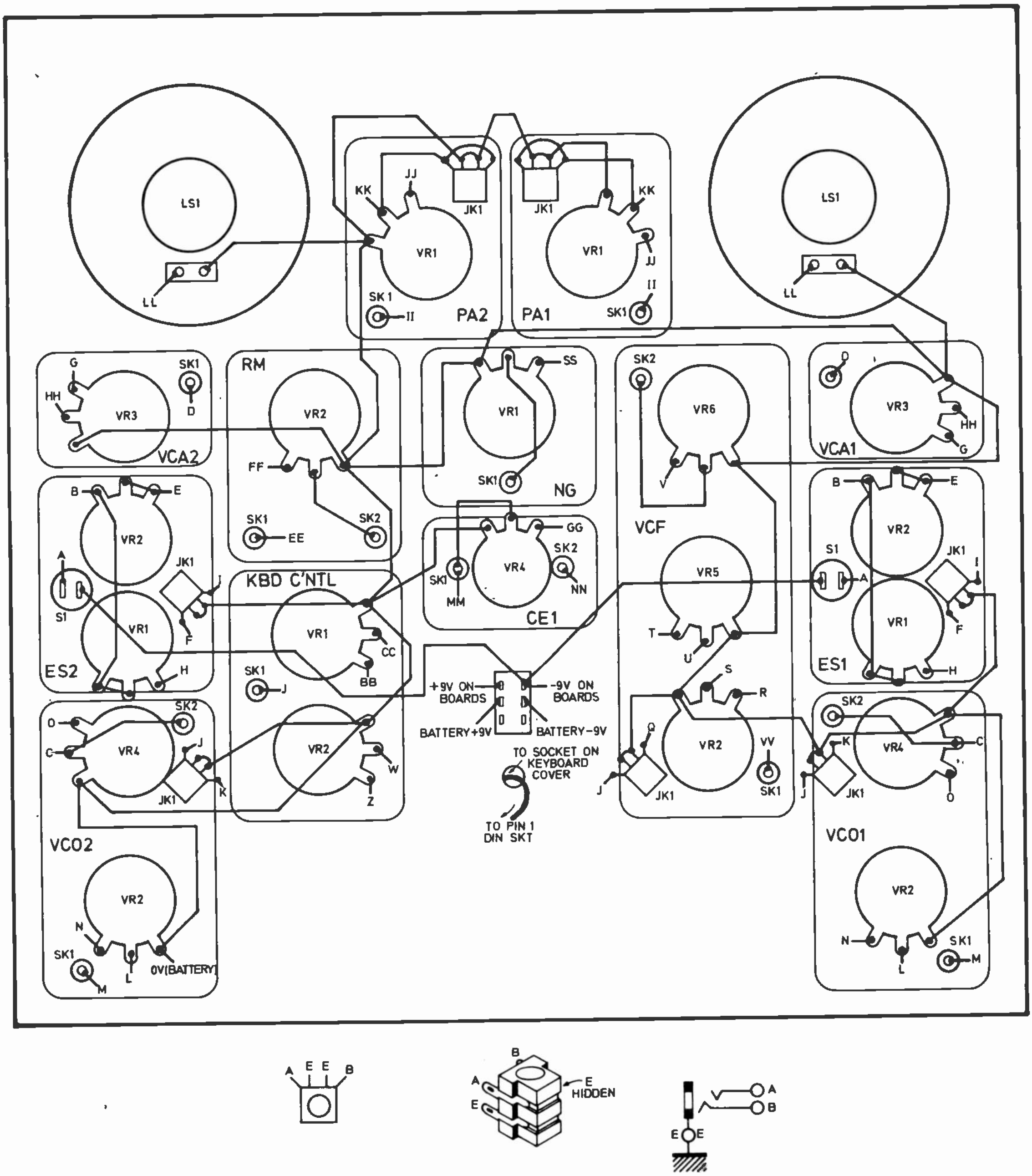


Fig. 4.1. The reverse side of the front panel. All interwiring on this panel has been shown; interconnections to the Veroboard panels are indicated by the lettered designations which correspond with letters on the Veroboards. The jack sockets are shown in detail to simplify wiring

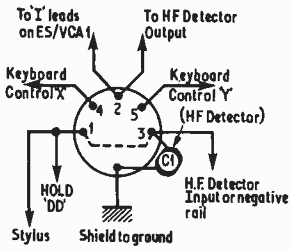


Fig. 4.2. Wiring of the DIN socket on the front panel. The link between pins 1 and 3 may not be necessary for some keyboard options—see text. The connection from pin 1 to the HOLD should go via a 20kΩ resistor (R7, Fig. 3.5)

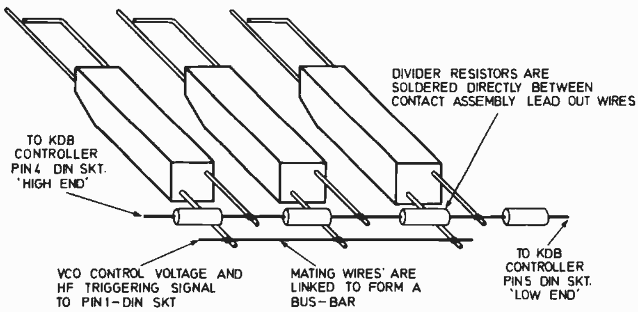


Fig. 4.3. The wiring of the single pole contact assemblies in a conventional keyboard. Only a three wire connection is necessary to the Minisonic. (Note: the normally closed contact wires have been omitted for clarity)

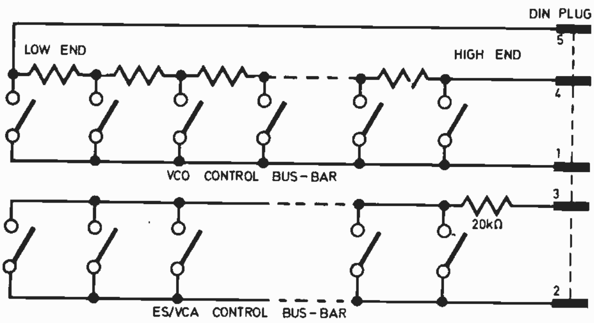


Fig. 4.4. Wiring arrangement for a conventional keyboard with double pole contact assemblies. In this case all five pins of the DIN plug and socket are necessary

KEYBOARD OPTIONS

1. Conventional Keyboard—single pole contact assemblies

The use of a keyboard of conventional style greatly improves the musical capabilities of the Minisonic and perhaps the simplest option here is to use a conventional style keyboard unit (the Kimber Allen type is recommended) which may be fitted with single pole changeover contacts of the Kimber-Allen G.J. type.

Wiring up is very easy and is illustrated in Fig. 4.3. After positioning the contacts such that the moving wires are central over their respective key actuators, connect up the moving wire lead-outs in the form of a busbar as shown. Divider resistors are now linked directly between the lead-outs on the normally-open contact wires.

Note that in Fig. 4.3 the normally-closed contact wires have been omitted for the sake of clarity.

Connection from the Minisonic to the keyboard unit in all cases is made via a DIN socket mounted on the front panel of the case. This has already been mentioned in the circuit diagrams of the HF DETECTOR last month. By simple changes in the wiring to this socket all the keyboard options to be described can be accommodated.

For this particular case a wire connection is made to each end of the divider chain and one to the busbar. All three wires are then taken to a DIN plug which mates with the DIN socket on the Minisonic. The "high" end of the divider chain goes to pin 4, the "low" end to pin 5, while the busbar goes to pin 1. The dotted link in Fig. 4.2 is required here.

If this option is adopted in addition to the printed circuit keyboard, then provision should be made to disconnect the latter keyboard divider when the external keyboard is in use.

2. Conventional Keyboard—double pole contact assemblies

With double pole contacts it is possible to trigger the Minisonic using the extra set of contacts rather than the HF OSCILLATOR signal superimposed on the VCO voltage input.

Referring to the DIN socket wiring, Fig. 4.2, disconnect the HF DETECTOR input and output from pins 3 and 2 respectively. Remove the link between pins 1 and 3 (shown dotted) and couple pin 3 to −9V via a 20kΩ resistor. VCO control voltages are brought to pin 1 as before while ES/VCA trigger pulses from the second set of contacts are brought into pin 2.

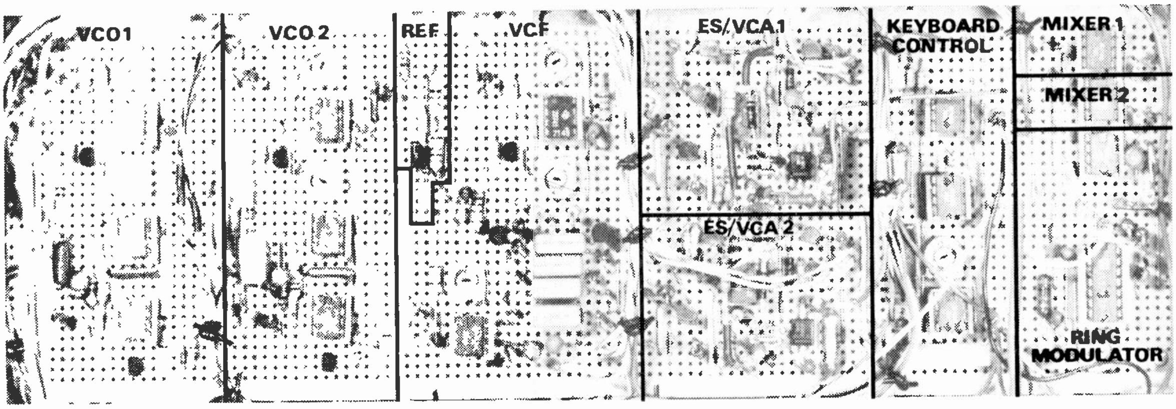
Fig. 4.4 shows a diagrammatic wiring arrangement. When this option is used the HF OSCILLATOR and DETECTOR may be omitted from the overall scheme. In any event the HF OSCILLATOR should be disconnected from the KBD CONTROLLER.

3. Existing Keyboard System—single pole contact assemblies

This option requires that the existing keyboard should offer negative control voltages and also that there should be a facility whereby the HF OSCILLATOR output may be evenly superimposed on the keyboard divider system. If these requirements can be met by the external unit then the procedure is as follows.

In Fig. 4.2 link pins 1 and 3. Disconnect the keyboard control voltages from pins 4 and 5. Disconnect the HF OSCILLATOR from the Minisonic KBD CONTROLLER and reconnect through a 1,000pF capacitor to either pin 4 or 5.

The mating DIN plug from the external unit will in this case require only two connecting wires: one carrying the HF signal to the external KBD CONTROLLER; the other bringing the VCO control voltage and the HF triggering signal to pin 1 as with the other options.



Photograph of complete board on which VCO's, VCF, Voltage Reference and ES/VCA's are mounted. (Note: some minor changes have been made to this layout)

4. Existing Keyboard System—double pole contact assemblies

With double pole contact assemblies the external unit will be supplying VCO and ES/VCA control voltages from its own resources. These voltages must be negative going. Pin 3 need not be connected to the negative rail.

It may possibly be necessary to include a resistor in series with pin 2 if the ES/VCA trigger pulse is in excess of −3V. For instance the *P.E. Sound Synthesiser* comes into this latter category, a 62kΩ resistor being necessary to attenuate the trigger pulse sufficiently.

FINAL SETTING UP

Assuming that all circuits have been constructed, bench tested and linked to the front panel controls as described, it now remains to get the instrument into action.

VCO BALANCING

The front panel controls should be set as follows:
AT MINIMUM ENVELOPE SHAPER attack and decay. VCF frequency. CE inverter.
AT MID POSITION VCO frequency, tune, span and VCF "Q."
AT MAXIMUM All level controls.

Switch on the power and apply the stylus—in the case of a conventional keyboard, press a key—around the midpoint of the keyboard. Both channels should be heard (the frequency is unimportant) almost instantaneously with the application of the stylus, with the sound dying away equally quickly when the stylus is removed.

Apply the stylus again and hold it in position. Tune one or other of the oscillators so that there is a slow beat between them. Advance the decay control to maximum and remove the stylus. The audio signal from the oscillators should now begin to die away over a period of about 16 seconds.

At this point however there will almost certainly be a change in oscillator frequency as the sound decays away. The problem is that the hold circuit requires to be finally balanced by means of VR4, Fig. 3.2a.

Without an oscilloscope it is unlikely that a very fine balance can be achieved but perhaps what is more important is that the instrument "sounds" right. Thus the stylus should be applied and removed with adjustment of VR4 being made during the decay period until finally there is no appreciable change in VCO frequency during the decay phase of the envelope. This operation requires some degree of patience since the closer the HOLD circuit is to balance the smaller will be the adjustments required.

SPAN CONTROL SETTING

Having balanced the HOLD circuit it now remains to set the KEYBOARD CONTROLLER span control such that the instrument can play an equal tempered scale. The situation is that the two VCO's are already tracking fairly closely with the tune and span controls in approximately their mid position. Tuning will be found easier however if only one oscillator is used.

Turn down the level control on one of the oscillators and advance the tune control to its maximum position. Run the stylus up and down the keyboard to ensure that the working oscillator frequency is within audible range at each extreme. If not adjust the oscillator frequency control accordingly. With the values given in the text of the series the equal temperament position will be found to be with the span control approximately in mid-rotation.

As with the HOLD circuit some patience may be required to get the tuning just right. Musicians with a sense of absolute pitch should not have too much difficulty in this respect but for the majority of constructors it will be a case of repeated adjustments and playing of octaves until the instrument sounds right.

An oscilloscope or frequency meter is a useful adjunct during these setting up procedures but is by no means essential. Having found the equal temperament position this should be carefully recorded since it is almost certain that the span control will be moved about again during the full evaluation phase of the instrument.

This completes the final setting up. Remaining checks on circuit performance may be made as follows:

VOLTAGE CONTROLLED FILTER

With the controls set as described, patch the output into a power amplifier external input. Turn both VCA level controls to minimum. Apply the stylus to the keyboard in about mid-position and check that no signal is present in the channel carrying the VCF output.

Advance the VCF frequency control to maximum. As this is done the VCO signal should become audible in the patched channel rising from a fairly bland sound to the full harsh bite of the sawtooth waveform as the frequency control of the VCF approaches its maximum setting.

Repeat this procedure with the *Q* control at both extremes. With *Q* at minimum the overall level of the sound should be somewhat greater than when it is at maximum but there will be less subjective change in the harmonic content of the resultant sound.

The next procedure is to check out the effect of automatically programming the VCF signal. Advance ES1 attack and decay controls to approximately one third of their rotation. Patch the output of the control envelope inverter into the control input of the VCF (jack socket). Set the CONTROL ENVELOPE level about halfway.

Application of the stylus to the keyboard will now result in a slow rise in audibility of the sound together with a distinct change in harmonic content as the sound becomes louder.

Try various settings of the attack, decay and envelope level controls to achieve a typical synthesiser "waa-waa" effect.

N.B. Remember that VCO2 is permanently linked into the audio input of the filter. The level control of VCO2 should therefore be at maximum for these latter checks.

RING MODULATOR

Remove the patch cords from the previous tests and patch the output of VCO2 into the uncommitted input of the RING MODULATOR. Patch the output of the RING MODULATOR into one of the POWER AMPLIFIER inputs and with both VCO level controls and the RING MODULATOR level control at maximum a resultant sound comprising the sum and difference of the input frequencies should be heard.

Try varying one or other of the VCO frequencies and note how the composite signal from the RING MODULATOR contains both rising and falling frequencies at the same time.

Removal of the patch cord from VCO2 should result in the complete loss of output signal from the RING MODULATOR. If this is not the case then VR1, Fig. 3.7, will require further adjustment.

NOISE GENERATOR

Patching the output of the NOISE GENERATOR into the POWER AMPLIFIER input should result in the immediate sound of white noise, a harsh, uneven rushing sound.

Having established that the main functions of the Minisonic are operating as described the constructor may now wish to make further investigation into the performance of the instrument.

Tracking of the oscillators at both extremes of the audio spectrum is a useful exercise particularly if the instrument is to be used for any kind of serious musical purpose. So far the checks on tracking have been limited to the measurement of current through the current generators. If this has been done with care there will be found to be very few problems with the audible trackability. Any measurement with a meter however is liable to error if fundamental precautions, such as ensuring good contact between the probe and measuring point, are not taken.

AUDIO TRACKING

Audio tracking should be carried out using the keyboard to supply the reference voltages to both oscillators. With the stylus at about mid-position on the keyboard, set the VCO's so that there is a slow beat between them, say around 2 to 3Hz. Now move the stylus to the top contact and, in this position, if the beat has increased so as to introduce a noticeable discord, then some adjustment will be necessary to VR3, Fig. 2.1, on one of the VCO's.

It should be borne in mind that this latter adjustment should be very small and also that it will change the frequency setting at mid-keyboard. Consequently after such adjustment the stylus should be moved back to the original contact and the manual frequency controls on one or both VCO's adjusted to achieve the slow beat again.

Do remember that with the law controls *exactly* matched any beat between VCO's is as the result of differences in bias on the control node induced either by the manual frequency controls or by the bias preset or by a combination of the two.

Such a difference in bias will result in a minute variation between the currents through the constant current generators which will increase as the overall bias increases. Thus a slow beat at say 250Hz fundamental will be rather more rapid at 1kHz fundamental but should not be so rapid as to cause a discord.

The constructor should not therefore try to iron out the beats completely since although this is a theoretically possible exercise it is also one which is calculated to try one's patience to the limit.

Another useful check is to measure the timing of the attack and decay phases of the envelope shaper as far as is possible in order to gain some idea of the effects induced by various settings of the respective controls.

TEMPERATURE STABILITY

The greatest problem experienced with constant current generators utilising a single, uncompensated transistor is that the current is anything but constant. Minor variations in ambient temperature can cause quite significant changes in V_{be} and thus in current through the transistor.

For this reason it was decided to offer, as an optional extra, the possibility of incorporating temperature stabilisation to the VCO's and VCF. The additional cost will be something under £2 (excluding Veroboard or PCB) and as such represents a good investment if the Minisonic is to be used for multi-tracking or more serious musical purposes.

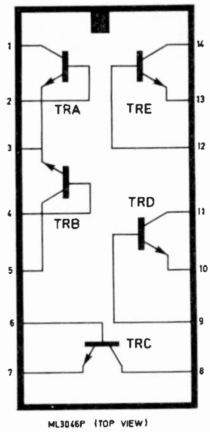
During a twelve-hour soak test on a Minisonic VCO the oscillator demonstrated a stability better than 0·2% per hour, a figure which would compare pretty favourably with most of the less expensive commercially available synthesisers.

STABILISER CIRCUIT

(Subject to Patent Application)

A full circuit of the stabiliser is given in Fig. 4.5.

TRA and TRB comprise part of a transistor array, the ML3046P. TRA is connected directly across the



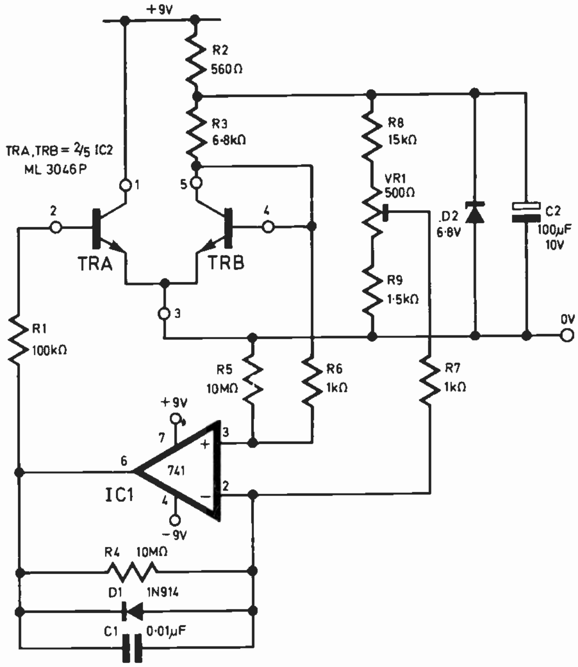


Fig. 4.5. Circuit of the optional stabiliser circuit

+9 and 0V rails and acts as a heater, the current through this transistor being limited by its own base current, which is, in turn, limited by R1. TRB is connected as a diode which is passing 1mA.

The V_{be} of TRB is compared by IC1 with a reference voltage set by R8, VR1, R9 which is nominally 660mV. IC1 is connected as a bounded integrator having a gain of about 10,000.

CIRCUIT ACTION

When power is first applied the transistor array is cold and thus the V_{be} of TRB will be greater than the reference voltage. The output of IC1 will therefore go rapidly positive turning on TRA which, with the output of IC1 at +8V, will pass about 7mA.

The effect is to heat up the transistor array which, in turn, causes the V_{be} of TRB to fall. The tendency will be for the V_{be} to fall to a point below the reference voltage at which time the output of the integrator will try to go negative. As soon as less current passes through TRA however the V_{be} of TRB will tend to rise again thereby signalling the requirement for more heating current to the integrator. In practice the circuit settles in about 30 seconds to a stable condition in which the V_{be} of TRB is maintained equal to the reference voltage.

In this situation the transistor array is kept at a constant temperature where the heat loss from the array is balanced by the heating effect of the current through TRA. Changes in ambient temperature will alter the heat balance of the system and thus cause a greater or lesser current to be passed through TRA. Similarly current passing through the other transistors on the array will also cause changes in the heat balance with the same effect.

SETTING UP

Setting up the so-called transistor oven is very simple. With a high impedance voltmeter connected to the output of IC1 and switched to the 10V range, set VR1 so that the wiper voltage is 670mV and apply power.

The voltmeter will indicate that IC1 has an output of +8V although this will begin to fall almost immediately and will settle, depending on ambient temperature, to a point between +2 and +4V. Gradually adjust VR1 until its wiper potential reads 660mV and again check the output of IC1 which, at this time, should be about +6V.

The criterion here is that TRA must, under cold conditions, pass a current which is at least equal to the maximum combined currents of all the other transistors on the array. If this were not the case then stabilisation would fall off in a situation where the remaining transistors were all passing their maximum currents (not a common situation in practice).

USING THE OVEN IN THE MINISONIC

The oven may be incorporated into the Minisonic scheme by removing the current generating transistors from the VCO and VCF circuits and linking in TRC, TRD and TRE respectively using three wires per transistor in order to prevent any problems which might possibly arise due to a circuitous negative rail return.

The control voltage/current relationship will have altered in the sense that higher currents will be passed for a given control voltage due to the fact that the array temperature is significantly above ambient. This may be compensated for by a proportional adjustment to VR1 in all control nodes so that the current levels are similar to those shown in Fig. 2.2.

The actual "law" is unlikely to have changed significantly and thus it should not be necessary to reset VR3 in any of the control nodes.

The maximum current drain of the "oven" will be about 11mA with a mean drain of about 7mA.

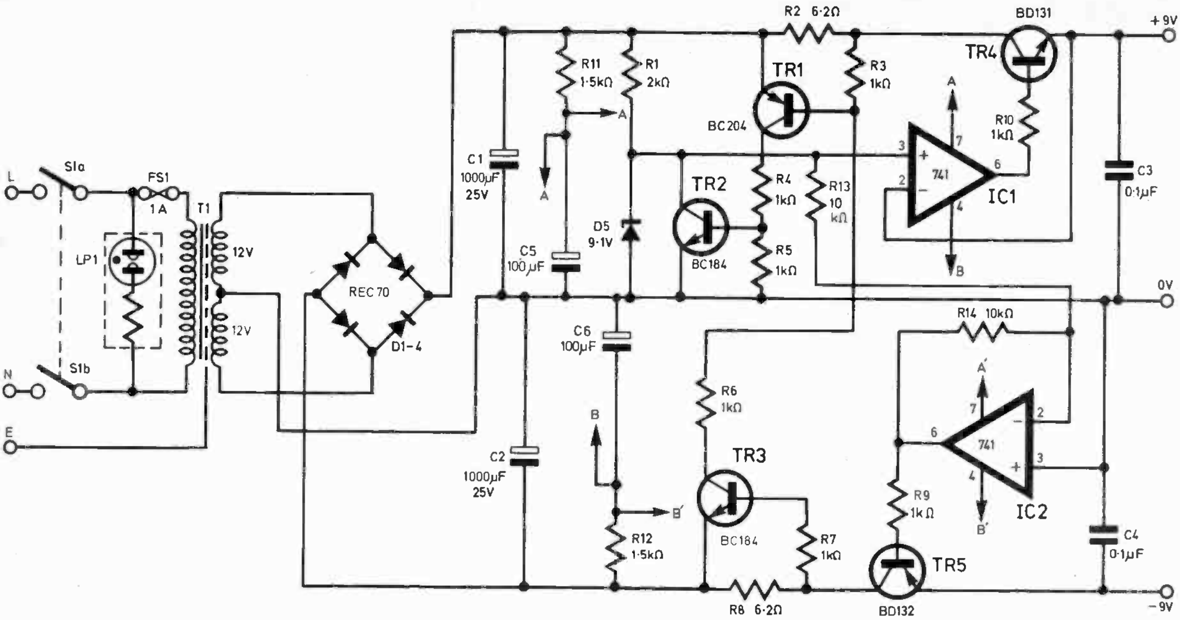


Fig. 4.6. Circuit of a battery eliminator for the Minisonic

POWER SUPPLY UNIT

The Minisonic was designed initially with the younger constructor in mind but it is a fact that, for the more serious experimenter, battery operation is not the ideal. Consequently a fairly simple stabilised power supply has been designed for incorporation into the instrument and is shown in Fig. 4.6.

CIRCUIT ACTION

Positive and negative rails are developed using a dual secondary or centre tapped transformer, a bridge rectifier and two electrolytic reservoir capacitors. D5 is a 9·1V Zener providing a reference voltage to the non-inverting input of IC1 which, in turn, provides drive to the series pass transistor TR4 which is operating as an emitter follower.

IC2 takes its reference from the same Zener diode as IC1 and provides drive to TR5, a complementary version of TR4. The arrangement of TR1, TR2 and TR3 provide short-circuit protection and current limiting.

Under normal conditions there is a minimal voltage drop across R2 and R8 and thus TR1 and TR3 are biased off. In this situation TR2 is also off.

If a short circuit occurs, say between the positive rail and ground, the voltage across R2 will rise rapidly thereby turning on TR1 and TR2.

The effect is to short out the Zener diode and pull down the outputs of IC1 and IC2 to zero volts. The power supply is thus effectively switched off. A similar action takes place if the short circuit occurs between the negative rail and ground or if the positive and negative rails are shorted together.

The values of R2 and R8 are chosen such that current limiting occurs when the demand is in excess of 100mA.

It should be pointed out that, at the time of writing, the performance of the power supply has not been fully evaluated and it may be necessary to make some adjustment to R2 and R8 in order that current limiting commences at the specified demand.

In general it is better to have R2 and R8 larger rather than smaller in relation to the specified value in order that limiting starts earlier. The specified series pass transistors are capable of handling up to 3A so it is unlikely that they would be too unhappy in the event of a short term overload particularly if the recommended transformer rated at 3VA per winding is employed.

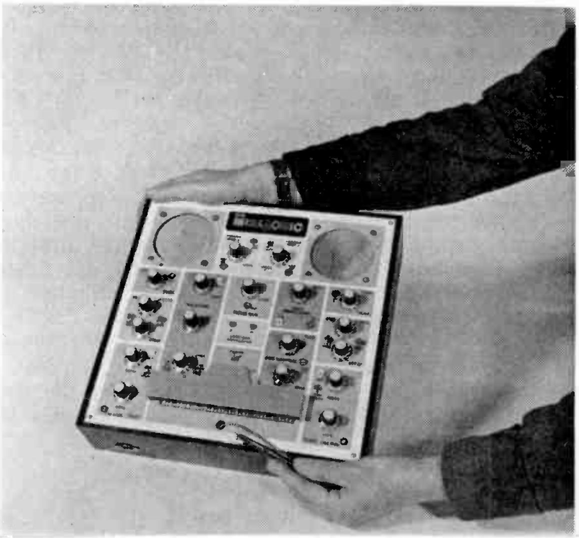
PRINTED CIRCUIT BOARD

As mentioned last month, the author has now developed a printed circuit which carries all the Minisonic electronics thus replacing the two Veroboard panels.

This will be available through certain of the advertisers in P.E. including Eaton Audio.

Next month: Making the most of the Minisonic

The completed Minisonic showing the DIN socket mounted on the front wooden panel



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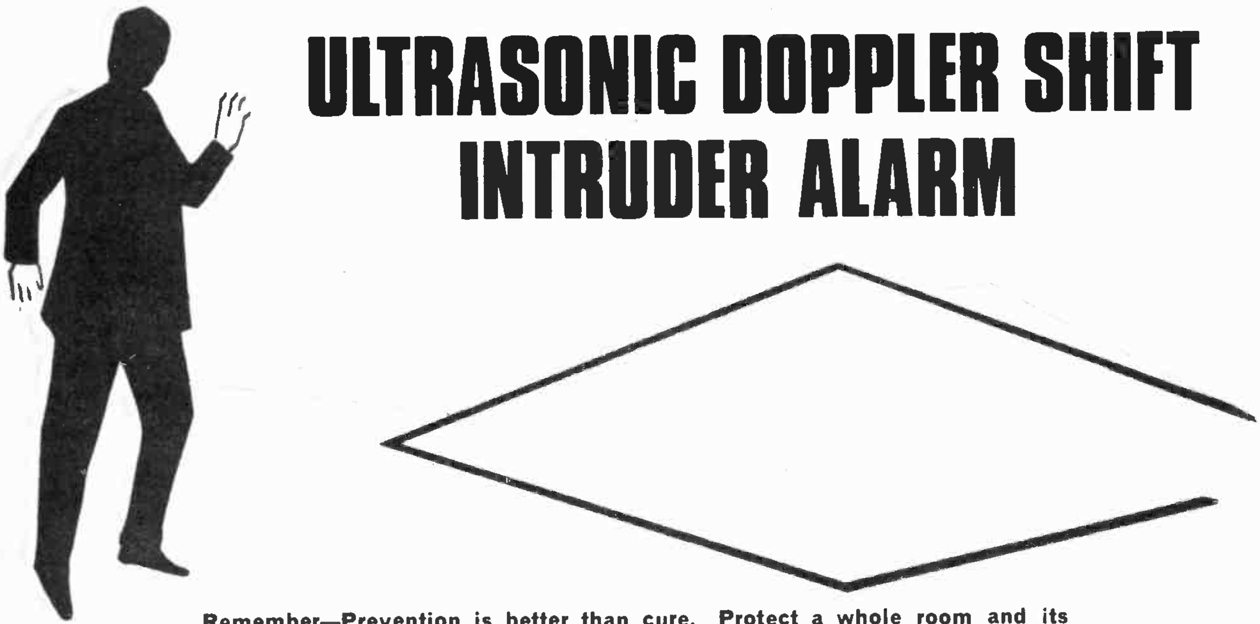

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PRACTICAL
ELECTRONICS

MARCH 1975 ISSUE ON SALE FEBRUARY 14, 1975

AC/DC MILLI-VOLTMETER

By A. J. WOOLLARD

To MEASURE low voltages across semiconductor junctions or switch contacts it is necessary to have a millivoltmeter with good overload characteristics. The unit described here can measure voltages down to 5mV and withstand 250V a.c. without harm.

SMALL VOLTAGES

The voltage dropped across a diode in the forward conducting mode, or a saturated transistor, is very much smaller than when the device is reverse biased. Also the voltage across a pair of relay contacts when closed varies with the current flowing through the contacts. The potentials for both these examples are almost invariably in the millivolt region and instruments capable of measuring such voltages are not always sufficiently well protected against very large input changes. Such changes occur when a transistor goes from on to off or a pair of relay contacts open. Careful use of integrated circuits and protection diodes allows an economic well protected unit to be constructed.

CIRCUIT THEORY

The instrument is designed around an operational amplifier with very high internal gain which is modified by the addition of external resistors. A.c. output for a.c. measurements is rectified by a bridge circuit to produce a unidirectional movement and indication on a moving coil meter.

OPERATIONAL AMPLIFIER THEORY

An ideal operational amplifier has an infinite voltage gain, infinite input resistance, zero output resistance, infinite bandwidth and zero offset voltage. A differential amplifier amplifies the difference between the voltages applied to its input terminals; a positive voltage at the inverting input produces a negative output, while a positive voltage at the non-inverting input produces a positive output.

Because of the infinite input resistance no current will flow into the amplifier and because of the infinite gain the differential input voltage, when negative feedback is applied, is zero.

Take the case of Fig. 1, a simple inverting amplifier. Since the differential input is zero, the voltage at the inverting input equals that of the non-inverting input (earth) and therefore the two currents are

$$I1 = \frac{V_{IN}}{R1}$$

$$I2 = \frac{V_{OUT}}{R2}$$

If no current flows onto the amplifier: $I1 = I2$

$$\text{and } \frac{V_{OUT}}{V_{IN}} = \frac{R2}{R1}$$

i.e. the voltage gain is dependent only on the values of the external components. Variation of R1 or R2 will then vary the gain of the amplifier.

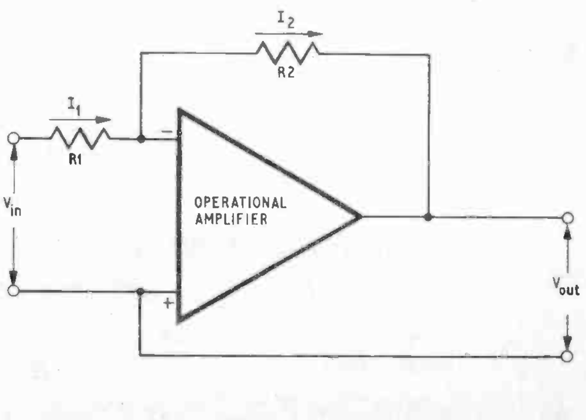


Fig. 1. Input/output relationships in a perfect operational amplifier

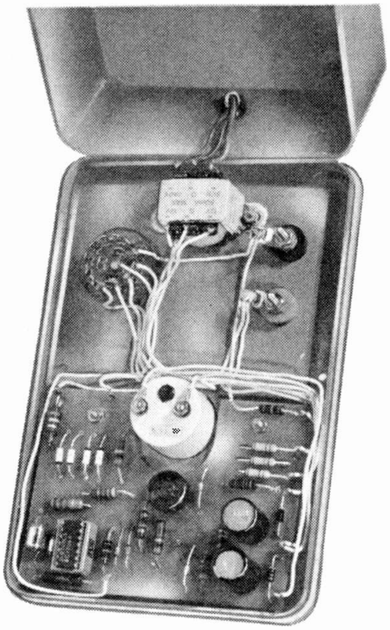
CIRCUIT OPERATION

The main gain setting elements in the full circuit, Fig. 2, are R8 and R10, corresponding in part to R1 and R2 of Fig. 1. These resistors should be precision types selected to 2 per cent or better where possible.

With switch S2 in the 100mV position the overall gain of the unit is determined by the ratio $\frac{R10}{R8} = \frac{10^7}{10^5} = 100$. Hence a 100mV signal at the input terminals will produce a 10V signal at the output of the amplifier.

To obtain different ranges, additional resistors R3, R4 and R5 are switched in, modifying the gain to 50, 25 and 10 respectively. These resistors should also be selected to better than 2 per cent. Indeed R4 and R5 are shown here as made up from selected components in series.

Components R11, C3 and C4 are compensation components chosen to keep the loop gain of the system below unity to prevent parasitic oscillation. These components limit the a.c. bandwidth of the meter so that signals up to 1MHz can be measured accurately.



OFFSET COMPENSATION

Although an ideal amplifier produces zero voltage at the output with both inputs earthed, in practice manufacturing tolerances cause an offset voltage to be produced, thus giving rise to an output voltage when both inputs are exactly equal in value.

The resistor chain R6, VR1 and R7 and R9 enable this offset to be compensated and the output set to zero voltage for zero input voltage.

PROTECTION

Diodes D5 and D6 are used to allow the input terminals to be connected to voltages in excess of 250V. By connecting them back to back both +ve and −ve half cycles of a.c. input waveforms are reduced to a safe level at the amplifier input.

To enable a.c. voltages to be read on a simple 1mA d.c. moving coil meter the bridge network D7–D10 is used. Resistor R13 (nominally 10kΩ) is used to obtain a 1mA signal from the maximum 10V output voltage. R13 can be adjusted as necessary to provide a suitable full scale deflection position by, for example, shunting with a large resistor.

POWER SUPPLY

To maintain the accuracy of the unit during periods of supply voltage and temperature variation, a stabilised power supply is necessary. A standard 12–0–12V transformer rated at 20mA is readily obtainable; diodes D1, D2 and Zener diodes D3, D4, together with R1, C1, R2 and C2 provide ±12V to the amplifier.

CONSTRUCTION

The choice of mounting methods is largely personal and a die cast box or plastics box are equally suitable. The prototype was built in a commercially available plastics "lunch box".

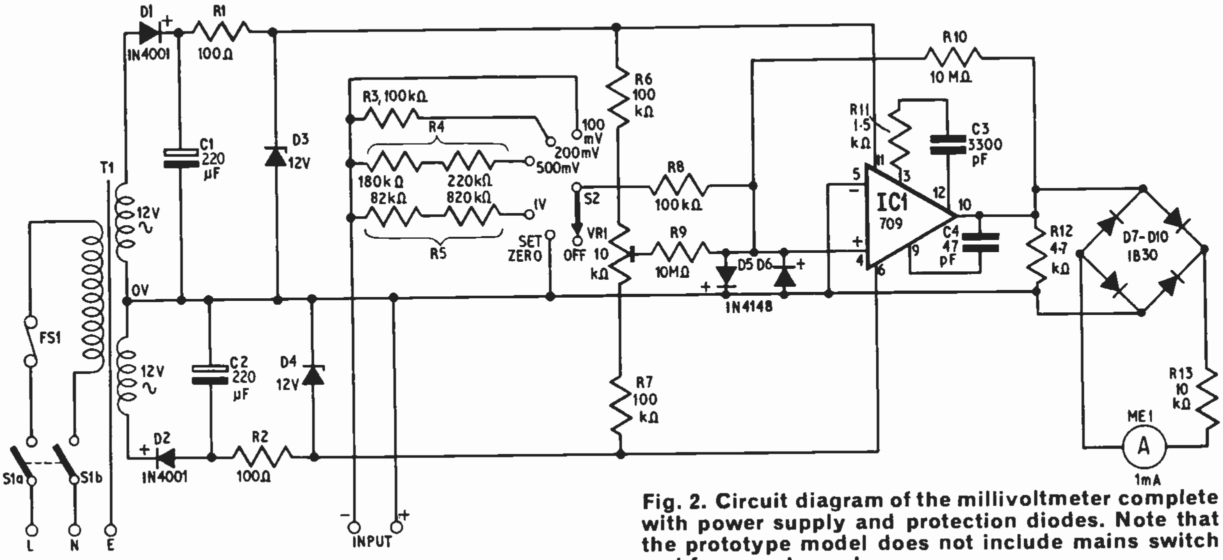


Fig. 2. Circuit diagram of the millivoltmeter complete with power supply and protection diodes. Note that the prototype model does not include mains switch and fuse as shown here

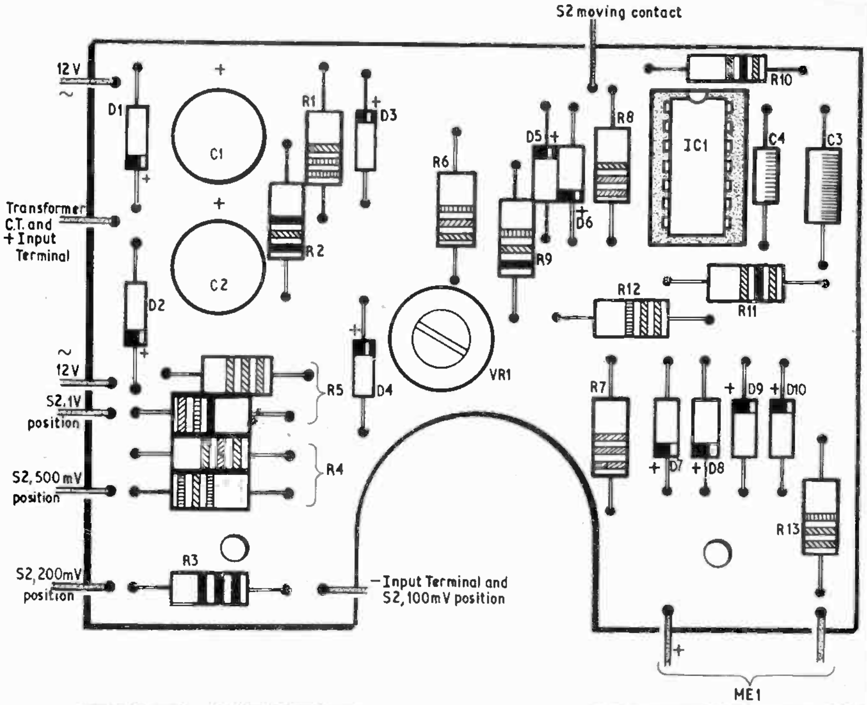


Fig. 3. Component layout for the p.c.b. of Fig. 4

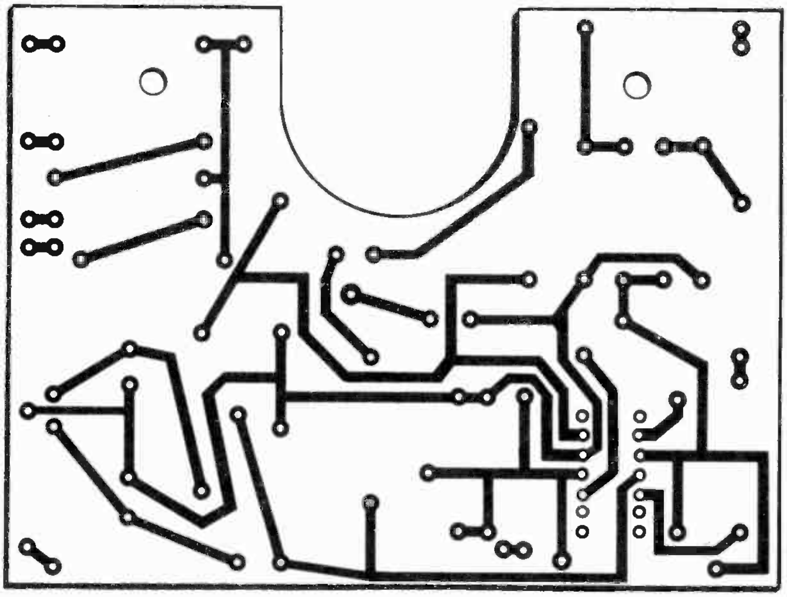


Fig. 4. Suggested p.c.b. layout as prepared for the prototype

COMPONENTS . . .

Resistors

R1 100Ω
R2 100Ω
R3 100kΩ
R4 180kΩ+220kΩ±2% ¼W
R5 82kΩ+820kΩ±2% ¼W
R6 100kΩ ¼W
R7 100kΩ ¼W
R8 100kΩ ±2% ½W
R9 10MΩ ¼W
R10 10MΩ ±5% ¼W
R11 1·5kΩ ¼W
R12 4·7kΩ ¼W
R13* 10kΩ ¼W See text
All 10% ½W unless otherwise noted

Potentiometers

VR1 10kΩ min. pre-set

Capacitors

C1 220μF 25V elect.
C2 220μF 25V elect.
C3 3,300pF ±10% 50V polysty.
C4 47pF ±10% 50V polysty.

Semiconductors

D1, D2 IN4001
D3, D4 12V Zener 300mW
D5, D6 IN4148
D7 to D10 1B30 or OA91, should be germanium for minimum voltage drop
ICl 709 operational amplifier

Switch

S1 D.p.s.t. mains switch
S2 Single pole 6-way

Transformer

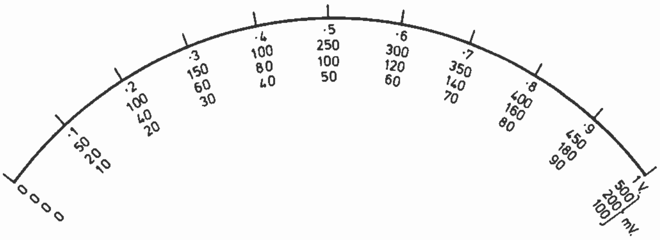
T1 Primary 240V, Secondary 12-0-12V, 20mA

Meter

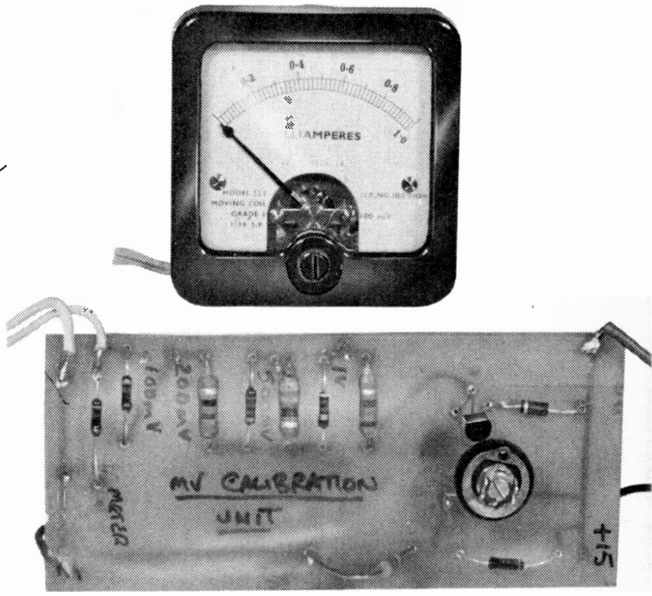
ME1 0-1mA f.s.d.

Miscellaneous

Case; knob; 2 insulated terminals; mains cable; miniature screened cable; copper clad board; cable retaining grommet; i.c. socket; solder tags: nuts and bolts. FS1, 2A



The scale used with a 1mA meter movement



The millivolt calibrator with the circuit made-up on a small p.c.b.

COMPONENTS . . .

CALIBRATOR

Resistors
- R14 2·2kΩ ±5% ¼W
- R15 2·2kΩ ±5% ¼W
- R16 6·8kΩ ±2% or better, ¼W
- R17, R18, R19 9 off 100Ω ±2% or better, ¼W
- R20 See text
- VR2 10kΩ min. pre-set

Semiconductors
- D11 5·1V Zener diode
- TR1 Any small signal p.n.p. transistor. See text

Meter
- ME2 0–1mA f.s.d.

Miscellaneous
- Board; wire etc.

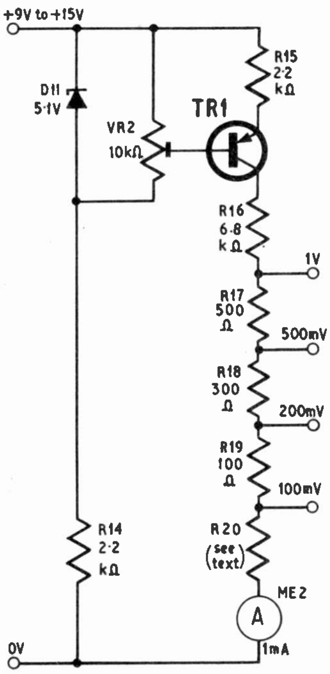


Fig. 5. A millivolt calibrator suited to checking the range f.s.d.s on the millivoltmeter

The most consistent results will be obtained if a printed circuit board layout is used, and advantage was taken in the prototype to try out the new fibre pens with etch resisting ink. A suitable p.c.b. layout for the circuit board is shown in Fig. 4 and a component layout in Fig. 3. It is suggested that an i.c. socket is used.

The mains transformer is best mounted away from the meter to prevent stray magnetic fields from affecting the calibration.

CALIBRATION

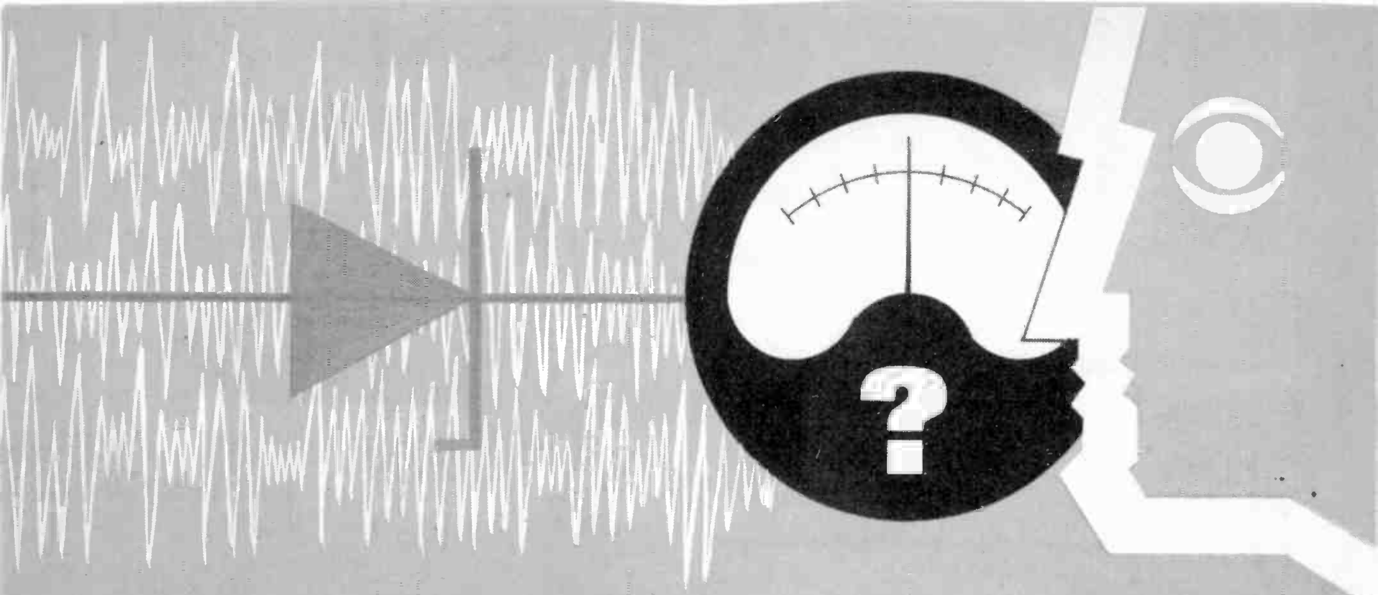
One of the major problems in having made the millivoltmeter is to ensure that it reads correctly. If precision resistors have been used for gain selection then the meter will read to within ±5 per cent. However if the only resistors available are ±10 per cent then a calibration procedure will be necessary.

It is first necessary to find a source of 100mV, 200mV, 500mV and 1V to enable the full scale deflection points to be marked and one way of doing this is to use the circuit shown in Fig. 5. TR1 can be any small signal *pnp* type with a reasonable gain at 1mA. The meter shown can be the same as that used in the millivoltmeter. Resistor R20 should be selected such that R20 + meter resistance = 100Ω. To obtain accurate calibration the chain of 100Ω resistors should be as close a tolerance as possible.

Next, with S2 in the "set zero" position shorting the amplifier inverting input to 0V via R8, VR1 is adjustable so that 0 meter current flows. Now calibration of each range occurs, starting with the lowest.

Should the millivoltmeter not produce f.s.d. when the 100mV calibration voltage is applied with S2 in the 100mV position then resistor R8 should be modified by adding series or parallel resistors. Similarly R3, R4 and R5 can be adjusted to provide correct f.s.d. for their respective ranges.

The unit should always be zeroed in the "Set Zero" position before calibration is checked. ★



Probability Anomaly Detector

By A. RUSSELL

IS IT possible to influence physical things by the power of thought? Using the Probability Anomaly Detector described in this article, it may be possible to provide evidence that mind can affect matter.

ZENER NOISE

When a Zener diode is biased near to its breakdown voltage, microplasmas form within the diode. Microplasmas are small areas of high ionisation created by radiation such as light. These microplasmas occur at random and cause small fluctuations in the voltage appearing across the diode.

If the power of thought is capable of influencing the photons which cause the microplasmas, then the circuit of the Probability Anomaly Detector (P.A.D.) should be able to detect the effect.

The noise from a Zener diode is used to trigger a Schmitt trigger when it exceeds a certain voltage. The output of the Schmitt is sampled at regular intervals and used to trigger a bistable, the output being fed to an integrator.

If the output of the Schmitt is purely random, i.e. the probability of being in one state is exactly equal to that of being in the other, then the output of the integrator, monitored by a meter will be zero. However a sequence of one particular state will cause the meter reading to rise. A scale has been prepared indicating the probability of a particular meter reading so that the amount of influence a subject has can be estimated.

CIRCUIT DESCRIPTION

The complete circuit of the P.A.D. is shown in Fig. 1. A Zener diode D1 is biased by R1 so that a spiky voltage appears across it. These voltage variations show the creation and destruction of microplasmas within the diode.

COMPONENTS . . .

Resistors

R1	100kΩ (see text)	R9	2·7kΩ	R17	10MΩ
R2	15kΩ	R10	15kΩ	R18	10MΩ
R3	220kΩ	R11	100kΩ	R19	22kΩ
R4	1kΩ	R12	15kΩ	R20	100kΩ
R5	10kΩ	R13	39kΩ	R21	15kΩ
R6	15kΩ	R14	1MΩ	R22	22kΩ
R7	1·5kΩ	R15	1·5kΩ	R23	22kΩ
R8	10kΩ	R16	10MΩ	R24	100kΩ
				R25	12kΩ

All ±10% $\frac{1}{4}$W carbon

Potentiometers

VR1 50kΩ
VR2 10kΩ
VR3 100kΩ
vertical skeleton preset

Capacitors

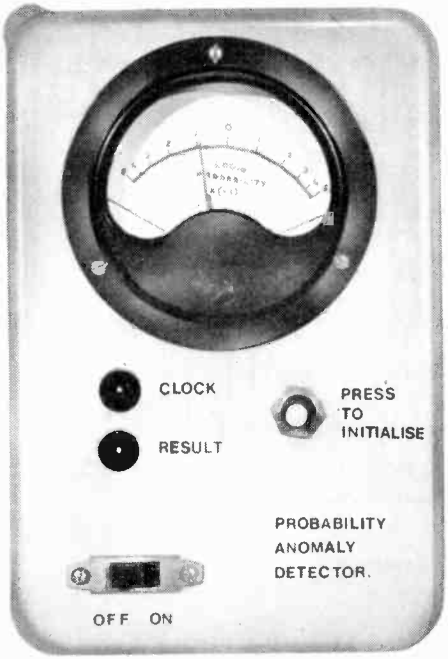
C1 0·1μF
C2 0·1μF
C3 10μF 15V elect
C4 0·47μF
C5 2·2μF 100V paper
C6 0·047μF
C7 0·047μF

Semiconductors

D1 10V 400 mW Zener
D2, D3 EC403 (2 off)
D4, D5 TIL209 or similar light emitting diode (2 off)
D6–D9 EC403 (4 off)
TR1–TR3 BC108 (3 off)
TR4 ZTX500
TR5–TR8 BC108 (4 off)
IC1 Type 741 8-pin d.i.l.

Miscellaneous

ME1 50–0–50μA meter
S1 Momentary contact pushbutton
S2 Double pole on/off
B1, B2 9V battery PP3 (2 off)
0·1in matrix Veroboard 5in × 2·7in
Suitable case



Front view of the prototype Probability Anomaly Detector

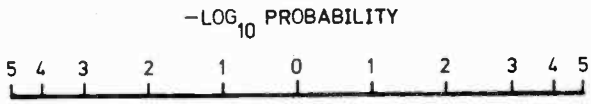


Fig. 2 Meter calibration

The diode voltage is amplified by TR1 and then used to fire the Schmitt trigger, the threshold at which it fires being adjustable by means of VR1.

Transistors TR5 and TR6 form an astable multivibrator which produces short pulses separated by about a second. Transistor TR4 acts as a gate which feeds the output of the Schmitt (controlled by the multivibrator) to the bistable TR7, TR8. After a burst of noise, suitably shaped by the Schmitt, the bistable takes up one of two states: either TR7 conducts and TR8 does not, or vice versa.

If no outside influence is operating the state of the bistable is determined at random. IC1 and C5 form an integrator. C5 charges or discharges depending on the state of the bistable so that a sequence of one state or another will cause a voltage to appear at the output of IC1 with a polarity depending on which state is repeated. The meter scale is suitably calibrated according to the passage of time (see Fig. 2).

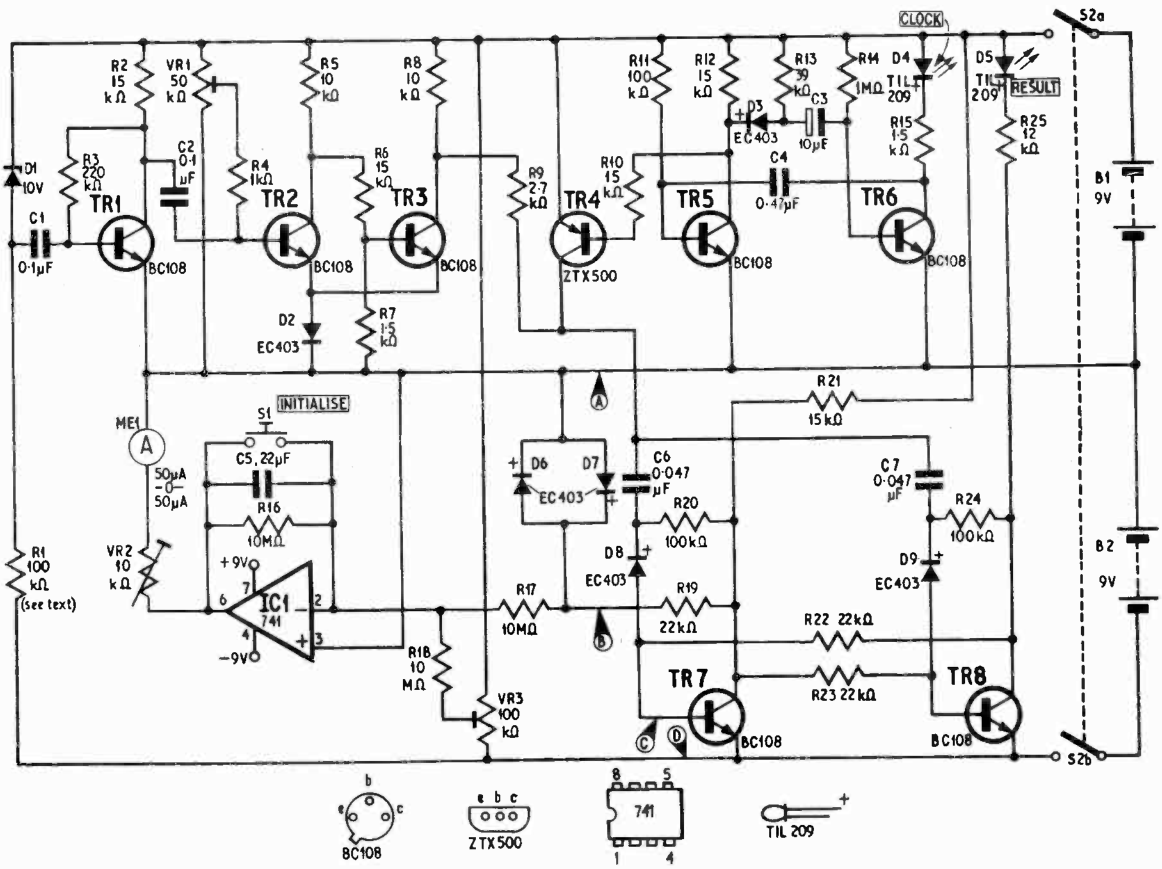


Fig. 1. Complete circuit of the Probability Anomaly Detector

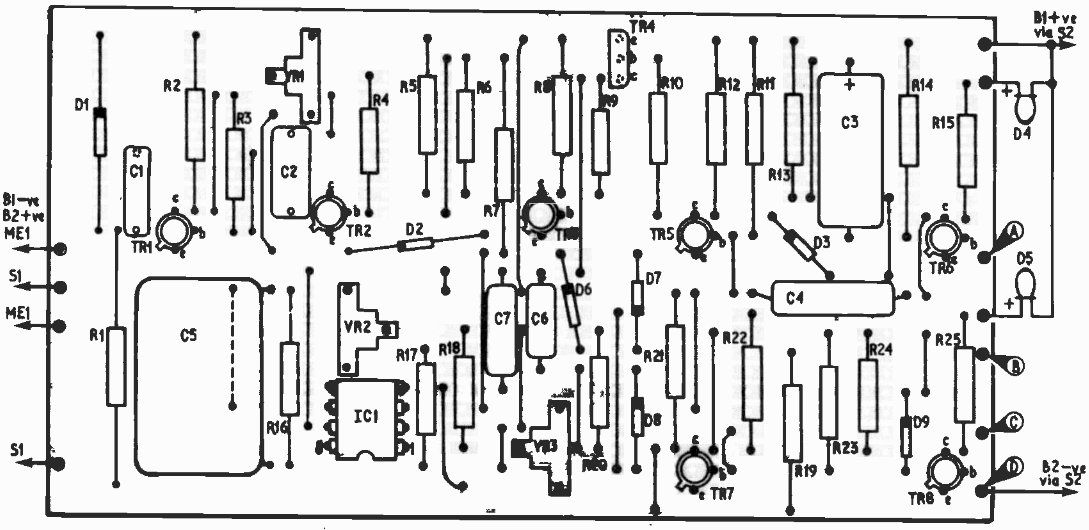


Fig. 3 Circuit layout on the Veroboard

To work out the calibration a computer simulation of the P.A.D. was created and after three days simulated operation figures were obtained as to how often certain sequences were likely to occur. The prototype used a 50μA-0-50μA meter ME1 as the output indicator. For extra information as to the working of the circuit two l.e.d.s D4 and D5 were used to indicate the occurrence of the pulse from the multivibrator and the outcome of each trial, i.e. the state of the bistable after the gating period.

CONSTRUCTION

The circuit can be built on 0·1in matrix Veroboard as shown in Fig. 3. The front panel layout is shown in the photograph, but layout is not at all critical. For testing the circuit a crystal earpiece was found to be an invaluable aid.

SETTING UP

Once the circuit has been built the following procedure should be used for setting up. First the output of TR1 should be monitored with the earpiece and R1 adjusted until the noise is a maximum.

Next VR1 should be set so that the Schmitt triggers on the noise from TR1. This can be done by setting the wiper at 0V, connecting the earpiece between TR3 collector and 0V, and turning up VR1 until oscillation is heard.

Next points A and B should be shorted and VR3 adjusted until the meter ME1 reads zero.

Points A and B are disconnected and points C and D shorted. VR2 is then adjusted so that the meter reading rises from 0 to 2 in 10 clock pulses.

USING THE P.A.D.

After resetting the P.A.D. by pressing the INITIALISE switch S1 the experimenter should concentrate on the meter and try to force it to a high reading in a particular direction.

If a high reading does occur, the experimenter should then try to get a high reading in the opposite direction, thus eliminating the possibility of drift in the P.A.D.

If the state of the P.A.D. was purely random then it would be expected that the meter reading would be as follows:

Above 0	almost always
Above 1	1/10th of the time
Above 2	1/100th of the time
Above 3	1/1000th of the time, etc.

The higher the meter reading the more unlikely is the possibility that the cause is of a random nature.

★

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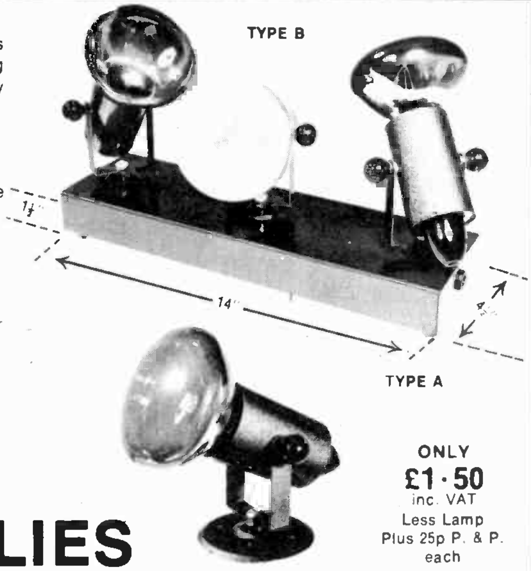

TYPE B 3-BANK UNIT

Has two brackets to accept P/C Board. Transformers. Also has holes in ends for Potentiometers. Jack Socket. Cable, etc. Ideal for making Sound to Light and Strobes. Base Cover included. Less Lamps. only

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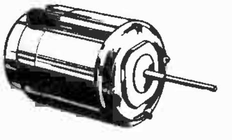
"SLO-SYN" 3-LEAD SYNCHRONOUS STEPPING MOTOR



Type SS15. These fine motors are easily reversed starting and stopping in less than 5° without electrical or mechanical braking. Simple relay circuit can be applied to give DC. to winding for a maximum holding torque of 300oz/in with 35v at 0·35 amps through winding. For AC. (synchronous) operation at 120r. 50Hz. Speed 60 rpm at 60Hz. 72 rpm. STEPPING Holding torque at 50 steps per second—100 oz/in. Can be wired to give 100 or 200 steps per revolution with accuracy of 0·1° per step non-cumulative. Torque characteristics can be modified by simple R.C. circuits. Dimensions: dia. 4". body length $4\frac{1}{2}$". spindle length $2\frac{1}{2}$" × $\frac{5}{16}$" dia. Weight $6\frac{1}{2}$ lbs. BRAND NEW in maker's packing. Offered at less than $\frac{1}{2}$ maker's price.

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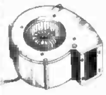

30 segments individually balanced in heavy cast alloy case. 2,300 r.p.m. 240 V a.c. Very powerful and silent running. $5\frac{1}{4}$" dia. 3" inlet dia. Outlet flange 3" × $2\frac{1}{4}$". Limited number only £8·95. P. & P. 40p.

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This little unit gives vertical lift of approximately 1" through hinged "elbow". Bracket incorporates 2 fixing screws. Length of arm $2\frac{1}{4}$". 240V AC. Pull at coil is approximately 1lb. £1. FREE P. & P. Special quotes for quantities.

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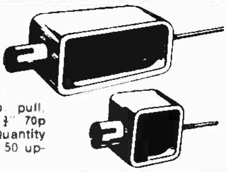
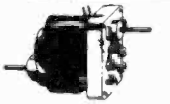


240AC type MM6. 3lb pull. $2\frac{1}{2}$" × 1" × $1\frac{1}{2}$". Travel 1". 90p. each. P. & P. 10p. 240AC type MM4. 2lb. pull. $1\frac{1}{4}$" × $1\frac{1}{4}$" × 1". Travel $\frac{1}{4}$". 70p each. P. & P. 10p. Quantity discounts 10–50 10%. 50 upwards 25%.

OPEN FRAME shaded pole GEARED MOTORS



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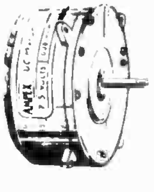

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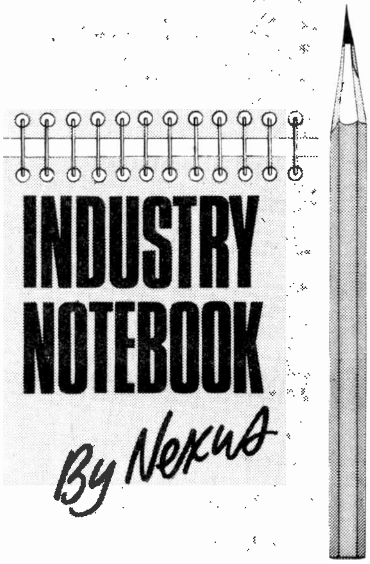

LOOK TO THE EAST

With what looks at best, a two-year period of stagnation ahead in Western Europe and North America the trade prospects in Eastern Europe suddenly look more attractive to businessmen.

I recently spent over a week in Hungary visiting the first ever all-electronics exhibition in Budapest. Previously, electronics had to take its place with other industries in general trade fairs so MIPEL 74, as it was called, was a great innovation.. By Western standards it was a pretty small affair but this suited the eight British companies exhibiting because they then stood out prominently as the largest national group exhibiting except for the Hungarians themselves.

All the fringe countries of the Eastern bloc have growing markets and general expansion in an effort to catch up with the West in living standards. Budapest, for example, has its traffic jams morning and night, neon lights in abundance, plenty of goods in the shops and a general air of well-being. The great leap forward can be traced back to 1968 when the economic system switched emphasis to profitability. Experienced travellers in Eastern Europe tell me that Hungary is the exception rather than the rule but there is no question that the trend is upwards and the demand for Western technology is considerable.

Trading with the East is a laborious business. All orders have to go through state-controlled trading companies and this alone builds up frustration and needs the exercise of much patience. There are problems with the COMECON embargo which limits the level of technology you can pass on to the East, and the Eastern states are all short of hard currency. But despite all these snags, plenty of companies are finding the effort worthwhile.

A favourite scheme is to set up a sales office in Vienna to serve Eastern Europe but many companies are still able to manage from their home bases or through local agents. What are the rewards? In three years Beckman Instruments have built up a business approaching £1 million a year, Mullard, operating from the UK is doing £100,000 and International Rectifier say they are doing a five-figure turnover in dollars in only two years.

CMOS PRICE DIP

It doesn't seem all that long ago that one of Motorola's gripes was the unrealistic pricing policy in the semiconductor industry. If I remember rightly it was Texas Instruments that was then supposed to be the villain. But 1974 saw Motorola slashing prices of CMOS logic not once, not twice, but three times so that by year-end you could buy Motorola CMOS at only one third the price you paid in January.

It's all to do with the learning curve, yields, volume production and market shares. At the beginning of the learning curve the product is hard to make and yield is low (i.e. rejects are high). Because volume is small, unit costs are high. But once engineers start designing the device into new products, demand rises and because volume is now higher the learning curve is accelerated and yields become greater leading to much lower unit costs. It's almost a predictable pattern which, eventually leads to the happy state of affairs that you can now buy a quad NOR/NAND gate in 100-off quantities for less than the price of a packet of cigarettes.

Motorola say that using three-inch slices has helped the price reductions and the time from design to production has been found to be less than predicted. And that's what the price reductions are all about. But these brave words are not stopping competitors growling fiercely and forecasting a bitter fight for the fast-developing CMOS world market which is expected to overtake TTL in popularity by 1978/79. As one old-timer in semiconductors told me, "you gotta be crazy to stay in this business".

NEW USE FOR DOPPLER

The hole in the road is one of the worst of the British diseases and the automatically-timed temporary traffic lights to control single lane two-way traffic is one of the most powerful frustrations the motorist has to bear, especially when he can see that nothing is coming from the opposite direction. The temptation is to "jump" the light but frustration and temptation may both soon be a thing of the past if the temporary signals are fitted with a simple Doppler radar assembly.

The idea, put forward by Mullard applications engineers, is to fit the Doppler on top of the traffic lights to detect a moving vehicle approaching. The light will then switch immediately to green provided a similar Doppler radar at the other end of the obstruction detects no movement. It is quite simple to have a delay system and reversion to timed operation in cases of conflict or when traffic is heavy in both directions.

It's another example of expanding the market for electronics. The unit recommended by Mullard is a complete Doppler sub-assembly aimed primarily at the intruder-alarm market. It has an 8mW output and a range of 150ft and the whole transmitter/receiver is on a ferrite substrate only one centimetre square. You choose your own antenna which can be a waveguide, dielectric rod or printed circuit.

MONEY IN KNOW-HOW

Selling know-how is nice business if you can get it. A top performer is International Aeradio whose latest scoop is a contract extension worth £2·5 million for Saudi Arabia for operational and maintenance services for aviation communications at Saudi airports, civil and military.

Another of IAL's specialities is training air traffic controllers from all over the world. The base for this is now Kidlington Airport, Oxford, officially opened by Lord Boyd-Carpenter on November 22 last with the new name of the IAL College of Air Traffic Services. Fees are high, earning a lot of foreign currency and there are no raw materials to import.

Know-how of another kind goes into Britain's most successful avionics export, the range of head-up displays for combat and attack aircraft built by Marconi Elliott Avionics Systems. Latest score is over 2,000 systems exported, mainly to the United States.

QUOTE OF THE MONTH

"There are too many simple answers and not enough simple problems"—John Eger, director of the White House office of Telecommunications Policy, U.S.A.

INGENUITY UNLIMITED

A selection of readers' suggested circuits. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

MAKING PRINTED CIRCUIT BOARDS

MOST constructors will agree that the printed circuit method of construction for circuits is by far the most professional looking.

The constructor is faced with many ingenious methods of producing them, from gloss paint and brush to the special acid resistant pens now available. However, to draw or paint p.c.b. designs is a difficult task.

An admirable solution which I suggest is to use Letraset. Sheets of different thickness lines and patterns can be bought at good stationers.

The copper clad board is first cleaned and the design drawn lightly on the copper. Letraset lines are then rubbed over the pencil lines. Where connections are to be made full stops or dots are used for the termination points. When the design is complete the Letraset is rubbed firmly with the backing sheet provided. The p.c.b. is then immersed in a solution of ferric chloride until etched.

The result is a beautifully neat board that only needs cleaning and drilling.

F. Butterfield,
Leeds, Yorks.

ECONOMICAL TERMINATION FOR HOOK-UP WIRES

IN building logic demonstration circuits a large number of terminal sockets are required to provide various interconnections by means of patching leads. The cost of these sockets as well as that of the corresponding plugs can become high enough to discourage would-be constructors.

To overcome this problem I have used a simpler and cheaper alternative.

Each of the sockets for termination is made up of an i.c. pin socket which are available in long strips at about £1 per 100 from a number of advertisers in P.E. These are soldered to the appropriate copper strip of the Veroboard and a piece of thick-walled sleeving about 4mm long, and with a diameter which is a tight fit over the socket, slipped over it. (The outer sheath of a two-core cable used in telephone wiring was found most suitable.)

The combination of the i.c. pin socket and sleeving forms an effective termination which accepts single core hook-up wire and component leads directly, thus eliminating the need for costly plugs.

The sleeving acts as an insulator and at the same time protects the i.c. sockets from displacement as shown in Fig. 1.

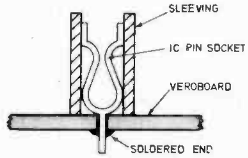

Fig. 1

C. S. Soh,
Singapore.

IN-CIRCUIT POWER DETECTOR

WHEN many devices are fed from a single mains supply it may be necessary to know that all of them are switched off. The circuit to be described illuminates a light emitting diode as long as power is being drawn from any source.

Diodes D2 and D3 are 10A 600V silicon diodes mounted on heatsinks. When current flows, 0·6V is developed across them. The germanium transistor TR1 conducts when 0·2V appears between base and emitter. R2 limits TR1 base current and R3 provides a low impedance path which prevents the induced e.m.f. in the neutral lead from switching on TR1.

The l.e.d. (D1) lights at a mains current of only 2mA and attains full brilliance at 7mA.

S. Beer,
West Byfleet, Surrey.

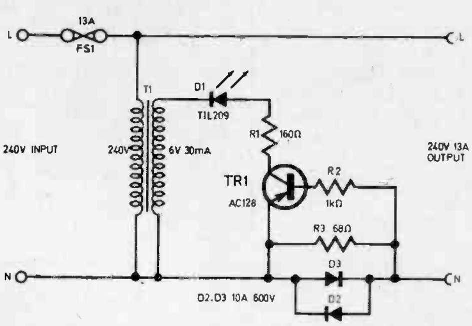

Fig. 1

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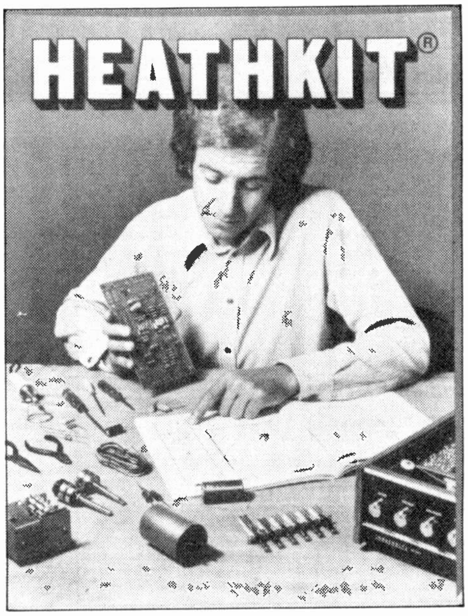

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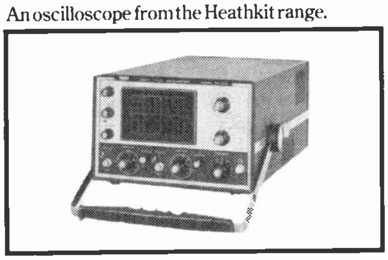
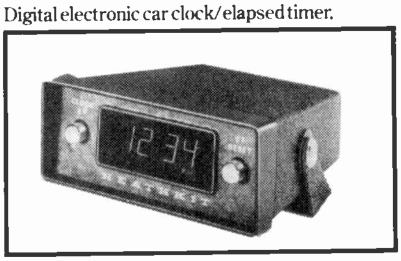


Digital electronic car clock/elapsed timer.



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C	3/4	4·7–10M	1·5	1·2	0·97 nett
C	1	4·7–10M	3·2	2·5	1·92 nett
MO	1/2	10–1M	4	3·3	2·3 nett
WW	1	0·56–3·9Ω	12	10	8 nett
WW	3	1–10K	9	8	6 nett
WW	1	0·22–0·47Ω	16	14	11 nett
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2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	8p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
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0·068, 0·1, 0·15 each 4p
0·22 5p; 0·33 7p; 0·47 8p; 0·68 11p; 1·0 14p; 1·5 21p; 2·2 24p

SILVERED MICA. *Working voltage 500V d.c.*
Values in pFs—2·2 to 250 in 9 stages each 6p
1000, 1500, 1800 9p; 2200 10p; 2700, 3600, 4700, 5000 16p; 6800 20p; 8200 10,000 25p

TANTALUM BEAD
0·1, 0·22, 0·47, 1·0 mF/35V, 1·5/20V, 3·5/16V each 15p
2·2/16V, 2·2/35V, 4·7/16V, 10/6·3V each 15p
4·7/35V, 10/16V, 22/6·3V each 20p
10/25V, 22/16V, 27/6·3V, 100/3V, 6·8/25V, 15/25V each 23p

POLYCARBONATE
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0·018; 0·022; 0·027; 0·033; 0·039; 0·047; 0·056; 0·068; 0·082; 0·1 each 5p

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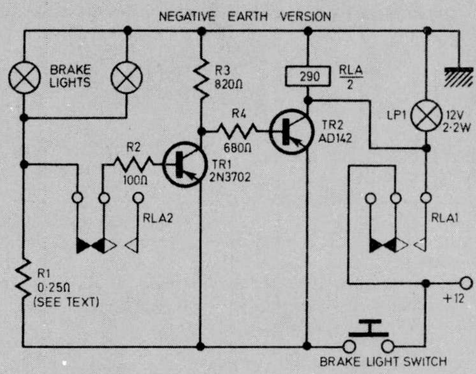

Fig. 1

The idea of the circuit shown in Fig. 1 is to detect when one or both of the brake lights has failed and then turn on a failure warning indicator and to keep this lamp on even after the brake pedal has been released.

When the brake pedal is pressed current will flow through R1 to the lights. This resistor is chosen to drop 0·7V which hardly affects the brilliance of the lights. TR1 becomes forward biased and turns on, holding TR2 off and thus keeping the relay de-energised.

If either lamp fails insufficient current will flow through R1 to cause TR1 to conduct so TR2 will energise the relay. The contacts are wired in such a way as to keep LP1 on even after the pedal is released. The relay can be turned off by the ignition switch.

Relay contact RLA2 open circuits TR1 base to reduce TR2 collector current to around 70mA when one or both lamps have failed.

Resistor R1 must dissipate about 1·75W so four 1Ω 2·2W resistors in parallel are recommended. Relay RLA was an RS 12V low profile type, drawing 18mA.

R. Pravel,
Ascot, Berks.

TOUCH TUNER

The circuit shown in Fig. 1 was designed as a touch tuner for the *P.E. Pushbutton Varicap Stereo Tuner* but has not been tested and so is suitable only for the novelty experimenter.

Using skin resistance, two bistables are triggered to feed preset voltages to a Varicap f.m. tuner. By placing one finger on the common positive supply contact and another on one of the three inputs, either TR1, TR2 or TR3 will conduct and the appropriate diodes will direct current to one of the bistables. The diodes are necessary to prevent interaction between the bistables.

With TR4 and TR7 on, and TR5 and TR6 off, the tuning voltage is set by VR2 as in the original tuner. When TR4 and TR6 are on, and TR5 and TR7 are off, VR3 and R10 are effectively connected in parallel across VR2 so that a lower tuning voltage is selected. Similarly with VR1 and R7, when TR5 and TR7 are on, and TR4 and TR6 off.

One disadvantage of the circuit is that if the radio is turned off the same station will not be returned when switching on again. Also, it may be necessary to prevent TR5 and TR6 operating together by connecting a small capacitor (say 0·1μF) from their bases to the negative supply line so making sure that on switch-on TR4 or TR7 switch on first.

High gain silicon transistors such as BC109's should be used throughout.

Note that VR2 will always be set to bring in the station with the highest operating frequency. Touch inputs should be kept short and well away from electromagnetic fields such as mains transformers.

R. Keeling,
Loughborough, Leics.

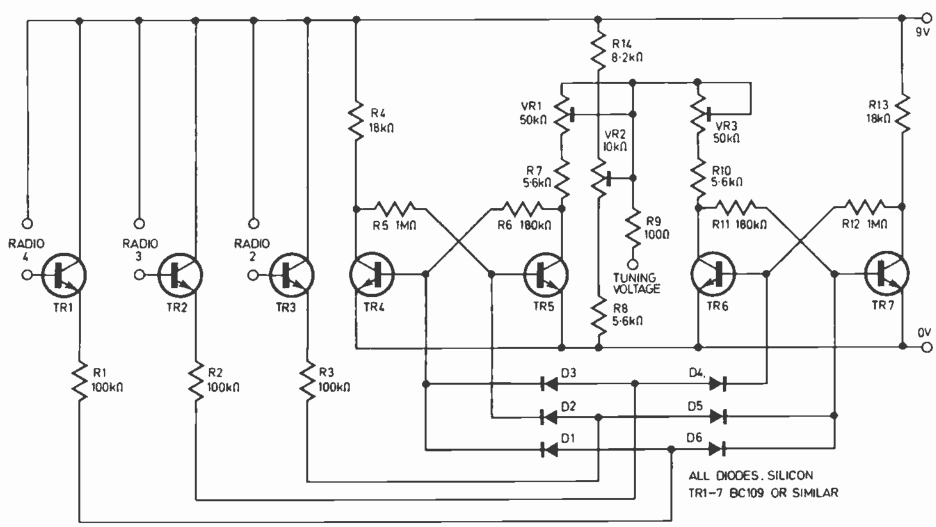

Fig. 1

VOLTAGE CONTROLLED AMPLIFIER

The voltage controlled amplifier circuit of Fig. 1 may be of interest to readers as the basis of other control circuits. TR1 is an OC200 or equivalent and TR2 an OC71 or equivalent.

In the circuit, when TR1 base is near ground potential the transistor is held 'off' and thus acts as a resistance in the potential divider chain including R1. As the collector-emitter resistance of TR1 is large compared with the value of R1, the input signal will appear at the base of TR2 and be amplified by that device.

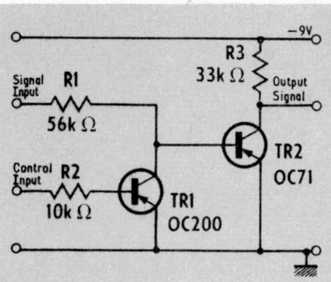

Fig. 1

As the base of TR1 is made positive and the device switched into the 'on' state the input signal will be effectively shorted to ground as far as the input to TR2 is concerned and thus no output will appear.

Initially the circuit was developed for a synthesiser so decoupling was not important but ideally a capacitor should be used to decouple with the result that only a.c. signals can be passed. The control voltage input can be from such sources as an envelope shaper but it should be remembered that TR1 requires a positive (ground) signal for 'on' conditions. R2 can of course be part of the preceding circuitry if required.

Very little control signal if any at all will appear at the output and since TR2 is floating it will not switch on or off.

P. D. Maddison
Blackburn.

SCHMITT DOES EVERYTHING

Frequently the home experimenter encounters the need to produce a few circuits cheaply which involves casting around for ideas to minimise the number of components required to fulfil a given circuit function.

It isn't a bad thing to aim for simplicity anyway; you get your results quicker and systems tend to be cleaner and more reliable all round. Readers may find my solution to the need for three pulse type circuits based on a simple Schmitt circuit useful, particularly as the idea is capable of extension. The heart of the system is depicted in Fig. 1 and around this basic circuit it was possible to evolve a relaxation pulse generator, a pulse stretcher and a trigger circuit for a triggered oscilloscope time base.

The detailed circuits evolved appear in Figs. 2, 3 and 4 and from these it can be seen how simple each circuit has become and after a time the building of several systems around the central theme becomes almost second nature. Each can be guaranteed to work on switch on, the required operating conditions can easily be adjusted, and they are cheap.

The circuit of Fig. 2 is a pulse generator. This circuit has operated satisfactorily with C = 470pF as a fast pulse generator, or C = 4μF and R2 replaced by a relay coil giving a timed contact operation over some seconds. Excellent frequency stability with supply voltage changes is experienced. Transistors are all ZTX 330.

The pulse stretcher circuit of Fig. 3 can accept an input pulse of 1V, 1μs and this gives an 8V, 30μs output when C = 47pF. To stretch the pulse further, increase C. All transistors here are 2N3711.

The triggered timebase of Fig. 4 is quite simple. It can be seen from the circuit details that components are kept to a minimum, and the transistors are a cheap plastic variety. There are endless possibilities by way of variations on the basic theme. The circuit easily converts to a set-reset bistable and the resulting circuits usually allow a marked degree of simplicity to be retained. Why not try a few variations to meet your requirements—it's fun.

A. P. Dixon,
Basingstoke.

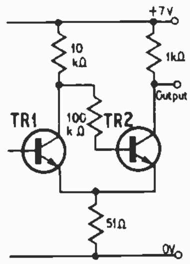

Fig. 1

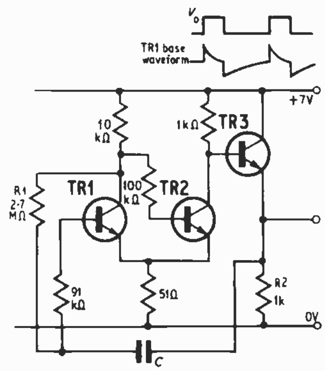

Fig. 2

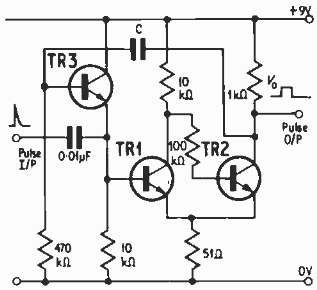

Fig. 3

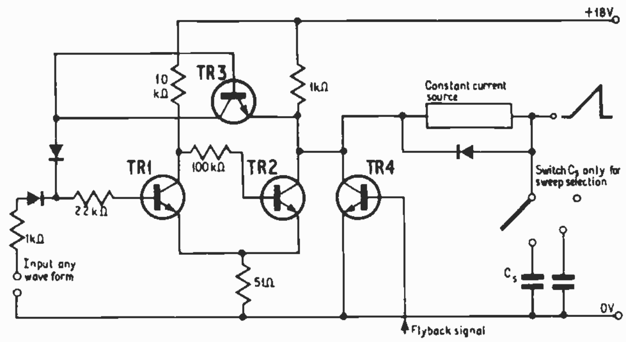

Fig. 4

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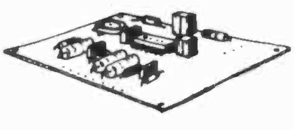

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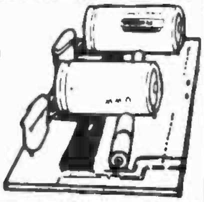

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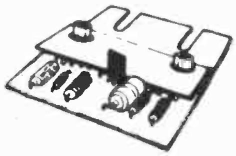

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PATENTS REVIEW...

COMBINED CCTV CAMERA AND RECEIVER UNIT

Anyone building the P.E. Monochrome CCTV Camera may well consider using it for closed-circuit communications. In BP 1 362 290, S.A. Engins Matra, of Paris, France, points out how CCTV communication, although electronically feasible, suffers from working problems.

The whole object of the exercise is, of course, that the correspondents at each end of the link should be able to both see and hear each other. But for one correspondent to watch the other on a monitor screen inevitably requires each to look at his screen and not at his camera. Hence neither can look the other in the eye! Also, although it is theoretically ideal to be able to illustrate a point with a diagram drawn for the camera, in practice this is easier said than done.

The French inventors propose a variety of mirror systems (of which one is shown in Fig. 1) which enable the camera and monitor at each end of the link to be effectively combined, together with a display surface for a diagram.

At each end of the link a light-tight box houses a receiver display tube and a camera. The optical axis of the camera and receiver are at right angles to each other, but a semi-reflecting plate (i.e. a see-through mirror) is angled at 45 degrees relative to each. The plate is also similarly angled to a front window of the box, and a lens, which forms an image of a diagram drawn or laid out on a display surface.

A correspondent can look direct into the display tube while being photographed by the camera. So if a similar arrangement is provided at each end of the link, both correspondents will be continually looking each other straight in the eye. Simultaneously, any object laid out on the display surface can be superimposed on the transmitted picture.

Transmission of a reasonable TV picture of a correspondent requires good room lighting and such light can cause unwanted reflections on the display tubes of conventional set-ups. But any room light which passes through the window and is reflected back off the receiver screen to the viewer will be attenuated by its passage twice through the semi-reflecting plate.

BP 1 362 290

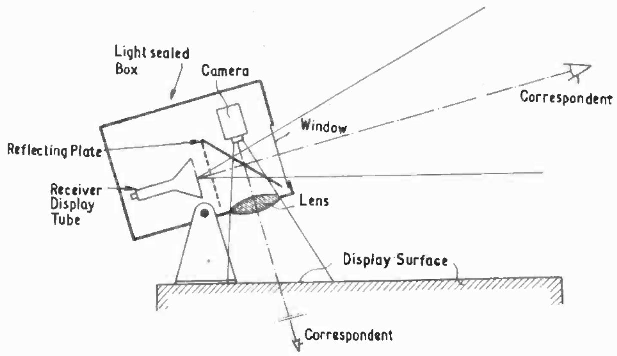


Fig. 1

IMPROVED PERSONAL RADIO AERIAL

In BP 1 354 710, Motorola Inc of Illinois, U.S.A., explain how there is a problem providing an aerial for a personal radio (e.g. police or paging type), which will operate on the range of 1–500MHz or more. Ferrite rods may be used but they claim that they take up too much space and are highly directional. Motorola suggest using part of the casing of the receiver as the aerial. Although this is not a new idea, the results are claimed to be an improvement over past achievements.

BP 1 354 710

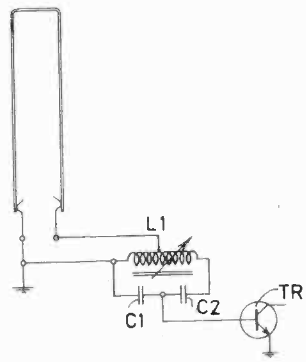
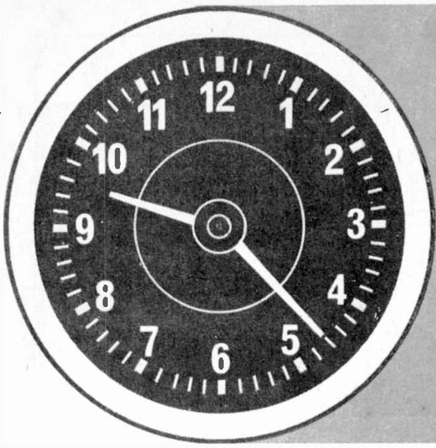


Fig. 1

The circuit, Fig. 1, shows a U-shaped metal cover which slides over the moulded plastic casing of a miniature radio receiver. The arms of the U mate with gold plated contacts on the receiver, one contact being connected to earth potential of the receiver chassis and the other to a reactance circuit which includes inductor L1 and capacitors C1, C2. The reactance contact is connected to an intermediate tap on L1 which has a movable core for inductance adjustment.

The reactance or tuned circuit is adjusted to be capacitive at the frequency of operation so that the connections to the U-shaped cover in effect connect a capacitor across the open end. The signal received from the aerial is derived from the reactance network at the common connection between C1, C2 and coupled to the base of TR1 which functions as an r.f. amplifier. Usually the receiver will be carried in a pocket with the earth arm adjacent to the wearer's body.

Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 25p each



CAR CLOCK REPAIRS

By D.L.COOPER

The modification described enables several years' additional life to be obtained from a clock which has failed due to contact wear.

THIS article describes a method of rejuvenating the type of electric clock used in a large number of cars up to about five years ago.

OPERATION OF THE CLOCK

The balance wheel of the clock drives the hands (through suitable gearing) in contrast with most other types of clock where the spring drives both the hands and the balance.

The balance is mounted between the poles of an electromagnet as shown in Fig. 1. When energised the balance rotates against its hairspring. The coil of the electromagnet is energised via a contact pin mounted on the balance, and a contact wiper in the form of a light spring arm.

When power is applied to the clock, current flows through the coil, along the spring arm to the balance wheel contact pin, and through the balance wheel hairspring to the clock frame. This causes the balance wheel to rotate until contact is broken.

The balance then swings back, makes contact, and is attracted in the opposite direction and the sequence is repeated.

WIPER ARM

When the clock is new the length of the wiper arm is set so that the balance wheel has to rotate a certain angle from its rest position before contact is broken. This is to ensure that the electromagnet is energised for long enough to give the balance a good push and keep it swinging vigorously.

However, as the contact wears (due mainly to arcing) the length of time for which the contacts are closed is reduced and the balance swings less vigorously.

In addition, if the contacts become dirty or pitted there may be intermittent contact.

Eventually the push from the electromagnet is not enough to overcome the friction in the bearings.

REPAIRING THE CLOCK

The ideal solution to the wear problem is to drive the electromagnet from a monostable circuit, triggered from the contact of the balance wheel. In this way wear on the contacts is greatly reduced as only transistor base current flows through them.

The period for which the contacts are closed is not important as the current flows for the full monostable "on" period. Dirty contacts have no effect since, once contact occurs to trigger the circuit, full current flows for the monostable "on" period.

CIRCUIT OPERATION

The circuit of the monostable is shown in Fig. 2.

The circuit is triggered when the contact closes, turning TR1 off and TR2 on. When the contact opens, TR2 is held on until the capacitor C1 charges via R1 and allows TR1 to conduct, whereupon TR2 turns off.

Diode D1 suppresses the reverse voltage transient in the coil after switch-off, protecting TR2. The values of C1 and R1 in Fig. 2 give an "on" time of about 20 milliseconds after the contacts open.

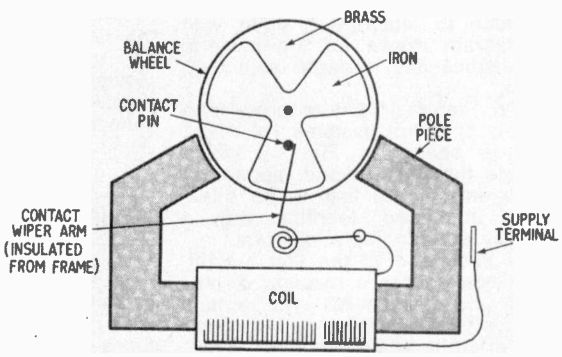


Fig. 1. Diagram showing the balance wheel mounted between the poles of the electromagnet in a typical car clock

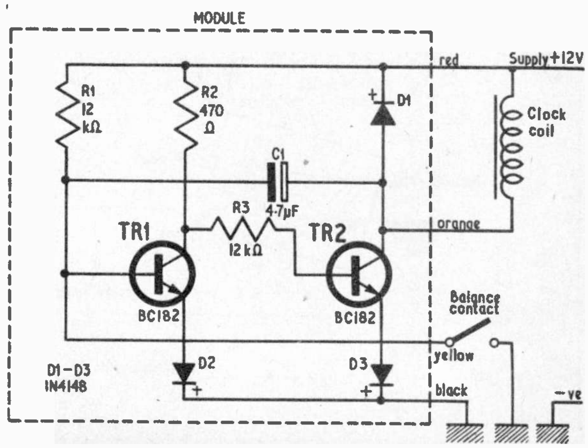


Fig. 2. Circuit of the car clock monostable

The circuit shown is for negative earth only and for positive earth cars all the diodes and C1 *must be reversed* and the transistors replaced by *pnp* types suggested in the components list.

All components must be miniature types to enable the finished circuit to fit inside the clock case.

The circuit is built up without a board for maximum compactness, component leads being soldered directly to each other. Thin coloured insulated wire should be used for the leadouts.

Once the module is completed it should be tested with the clock.

FITTING IN THE CLOCK

The clock must be removed from the car. The method of mounting varies but is usually a U-shaped clamp and two nuts accessible from behind the dashboard. Disconnect the supply leads to the clock, and the light if fitted.

Undo the four (or three) screws, washers, and rubber bushes on the back of the clock and remove small screw retaining the supply wire on the terminal post. Carefully prise off the chrome ring retaining the plastic face of the clock, sliding the face and clock mechanism out of the metal case.

The clock is very delicate and great care is needed if irreparable damage is not to be done, particularly to the balance wheel.

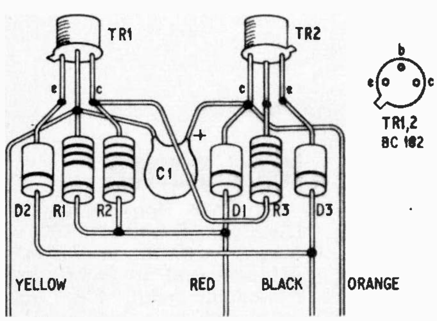


Fig. 3. Construction of the monostable module. After thorough testing this can be encapsulated in resin or insulating tape

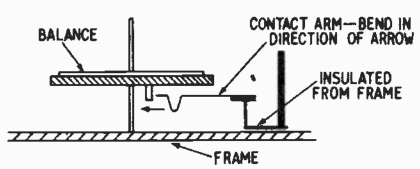


Fig. 4. Diagram showing the direction in which to bend the contact arm if the contact is at fault

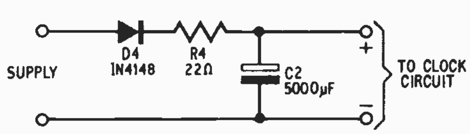


Fig. 5. Voltage regulator to keep the voltage constant while the starter is operated (Reverse D4 and C2 for the earth)

COMPONENTS . . .

Resistors
R1 12kΩ R2 470Ω R3 12kΩ R4 22Ω
All ±10% ¼W carbon

Capacitors
C1 4·7µF 15V elect. (miniature or tantalum bead)
C2 5,000µF 15V elect.

Diodes
D1-D4 1N4148 (4 off)

Transistors
TR1, TR2 BC182 (−ve earth version) or
BC212 (+ve earth) (2 off)

Miscellaneous
Sleeving
Resin for encapsulation

Unsolder the coil lead from the contact pin connection and connect the four leads from the monostable: red to the supply side; orange to the coil lead unsoldered from the contact pin; yellow to the contact pin; and black to the clock frame. Leave the leads fairly long at this stage.

TESTING

Connect the 12V supply between the supply pin and the clock frame in the correct polarity and gently spin the balance wheel.

If the clock keeps running for a few minutes all is well; if it stops check the monostable connections. If they are all correct temporarily short circuit the contact pin to the frame which should cause the balance to be attracted to one extreme of its travel. If it is, then the contact is at faut. Using tweezers or long-nosed pliers, very carefully bend the spring contact arm slightly closer to the balance wheel contact pin (see Fig. 4).

Check by applying 12V again.

ENCAPSULATION

When the clock is running properly, disconnect the four leads from the clock and either encapsulate the module by dipping in polyester resin or Araldite.

The completed module should be small enough to fit inside the clock case. Cut the leads to length and reconnect as before.

Replace the clock in the case making sure that the module and wires do not foul the mechanism. Fit the screws in the back and replace the chrome ring retaining the face ensuring that the knobs for hand setting and regulating are properly fitted.

Check again that the clock is still working and replace in the car.

VOLTAGE REGULATOR

If any trouble is experienced when the starter is operated this may be due to the fact that operation of the starter causes the battery voltage to fall so much that the clock stops. A capacitor and diode can be used to keep the voltage at the required level.

Connections are shown in Fig. 5.

It will probably be found that the clock runs fast after modification but this can be corrected with adjustment provided on the clock. ★

Readout—

A SELECTION FROM OUR POSTBAG

Readers requiring a reply to any letter must include a stamped addressed envelope. We regret that we cannot answer any technical queries on the telephone.

Stirring sounds

Sir,—I read with great interest the letter of your correspondent Mr. I. Stuart-Colwill in the December issue of P.E. There is nothing like a little controversy to get the blood stirring and whilst I would tend to go along with a number of Mr. Stuart-Colwill's comments I must say that I do not agree with all of his arguments.

As a starter I would agree that music is wallowing in the primeval mud—but no more so than any other art form. And I only agree with this sentiment in the sense that there are a great many musicians and composers who are struggling to express themselves in their chosen medium and in a way that can be understood by those of us who do not possess their gifts. That escape is possible from this "slough of despond" is clearly demonstrated by the works of such giants as Albinoni, Bach, Beethoven—yes, even Stravinsky and Schoenberg.

If one thinks about it at all, one comes to the inescapable conclusion that all acoustic instruments in use today are merely sophisticated versions of simple devices designed to imitate phenomena occurring in nature. Hence Malcolm Pointon's reference to natural sound, i.e. sound produced by physical processes such as a vibrating string—or column of air—or reed. This being the case one marvels all the more that with instruments of limited dynamic range and tone-colour, composers such as those cited above have managed to transcend all subjective aural boundaries and are still able to communicate emotionally with anyone who cares to listen.

The word "imitate" is a crucial one in reference to any art form. Thus there is no relevancy in the kind of fatuous remark made recently by one well-known critic on the BBC when he said that "All synthesisers sound alike." So too do all grand pianos—so what? It is not the instrument that matters so much as the performer's grasp of its potentiality and his ability to translate this into aural terms.

I agree wholeheartedly with Malcolm Pointon's view that the second half of the twentieth century is emancipated in a musical sense. Thanks to Robert Moog and his predecessors who pointed the way we now have musical instruments the like of which could not possibly have been imagined 20 years ago. With a dynamic range greater than a whole symphony orchestra, a frequency range encompassing the whole of the audio spectrum and a range of tone colour which defies classical description the synthesiser quite literally does make the aural universe boundless.

No, Mr. C, 1974 was not marked by your aquisition of a synthesiser. It was marked by the fact that hundreds of others like you also acquired one. Many will fall by the wayside, many will be content with imitative creations and many with cheap divider organs. But it only takes one composer with the imagination to transcend the current trend in synthesiser gimmickry and produce a work of any power at all for the synthesiser to find a firm place in the history of music.

G. D. Shaw,
Huntingdon.

Emancipated synthesiser

Sir,—How gratifying it was to read Mr Stuart-Colwill's letter "Discord" (*Readout* Dec '74). I whole heartedly agree with his views of electronic pop. How many times must we hear facile popular ditties (thumped out by people who are mistakenly regarded by many as "musicians") performed in a pseudo organ tone and sickly tremelo, on instruments which could do so much to change the history of music?

Perhaps we are offended even more by the frequency with which people, when the synthesiser is mentioned say, "Oh! that thing that plays all the Bach." Maybe I'm a musical snob, but I look on the pseudo-organ effect which is so often used with so little variation or modification in interpretations of Bach on synthesisers, as a detriment to the instrument and a slight to Bach. Would not Bach have fumed to see such an instrument shackled? We know that he was a keen experimenter and I personally doubt whether he would have forgiven the ravishes of the all too popular "Switched on Bach" records in which so little variation of effect is found.

Finally, I believe that the next 50 or more years will see a monumental battle for the emancipation of the synthesiser as an instrument in its own right. One only has to look at the influence of the old school of Gauttier and Co on the harpsicord style, to see that such a transfer of idioms is being attempted now, i.e. from organ to synthesiser.

Whilst some transfer is inevitable, total assumption of organ style cannot be allowed. The synthesiser must break away from the protection and influence of the organ and set up its own family.

P. Watson,
Bedfordshire.

New phase

Sir,—Mr Stuart-Colwill's letter (*Readout*, December 1974) is welcome; however in his attempted dampening of my enthusiasm he has missed the point of the article and let himself be carried away by quite a few red herrings.

Here in 1974 there is little doubt that we are in at the beginning of a new phase. Since Moog's musical application of voltage-controlled devices some ten years ago the market for synthesisers has widened considerably, and at this stage, thanks to PE and at least two other periodicals, interest in electronically produced sound has received an additional hefty boost.

Even Stockhausen in the early '50s could not have foreseen this enormous interest in electronic music. Many of his non-electronic works are still shunned by many people who can accept the medium of which, it would seem, only he knew the value. As for "primeval mud", my article implies that any new ideas in musical expression take time to settle and, having eventually settled, begin to develop towards the stage where it is felt that new ideas are needed; the process then starts all over again. Today's composers are still searching for a distinguishable point of reference.

My apologies for any ambiguity in the phrase "seven modes were employed". I hereby correct this to "seven modes were available". The Locrian mode was, indeed, a rare bird, but without expert musicological evidence I would hesitate to refer to it as a "joke".

Mr Stuart-Colwill's thoughts now fall into rather hot water. With all the will in the world Beethoven could not have produced the aural universe inhabited by, say, Morton Subotnick's "Silver Apples of the Moon". As for dynamic level, even Webern's "pppp" could not, in the very nature of the instruments at his disposal, fall below a fixed minimum level; neither could Wagner or Stravinsky, for all their fortissimi, rise above a measurably fixed maximum level. Under normal concert conditions one does not sit with one's ear rammed into the bell of a brass instrument.

As for the comment about Liszt and Paganini, of *course* they were deemed "inhuman" a hundred years ago, but ninety-nine years ago people started acquiring the necessary skills; teenage virtuosi these days rattle the stuff off without much sweat-and-tears. I still cannot see men, within the next millennium or so acquiring independent brains within a single skull-case or multi-fingered hands capable of intense rhythmic complexity.*

Finally, I would not go far to hear anyone's lash-up of Ravel's or Stravinsky's exotic scores. I see little point in rehashing—at great expense of time and money—music which is better and more economically performed by acoustic instruments, but then: chacun a son goût. When requested I, too, dish up "synthesised classics", although I admit to treating this kind of work as a useful recreative exercise in exploring the potential of a synthesiser rather than an eminently more satisfying personal creative act.

Anyone who uses a £7,500 synthesiser to imitate a cheap divider organ is welcome to do so. I do not applaud his aural perception but I do envy his bank balance.

Malcolm Pointon

*Read Olaf Stapledon's fascinating look at the far distant future in his two novels: "Last and first men" and "Last men in London" (Penguin Books).

ITT

Sir,—In your issue of October 1974, page 905, under the heading "Big Bad Wolf?" you list the various locations which come under the control of ITT Components Group Europe. One of the locations listed is that at Foots Cray and I feel I should point out that the Foots Cray site is not wholly directed by ITT Components Group Europe but contains other ITT Divisions such as ITT Semiconductors which is part of the world-wide activity of ITT, reporting directly to the ITT Headquarters in New York.

Roy Atterbury,
Publicity Manager

Our contributor Nexus, replies:

I was confining my comments to ITT Components Group Europe and the fact that ITT Semiconductors at Foots Cray reports direct to New York rather than to Brussels highlights, in my opinion, the different problems of manufacture and marketing of semiconductors as against other components. Semiconductor men need to think and co-ordinate strategy globally to stay in business.

ITT Components Group Europe, however, designs and manufactures quite a high proportion of components specifically for the European regional market and finds this economically successful. There are other factors, too, such as location of R and D facilities and general administration which have a bearing on the location of the control centre.

And although ITT Components Group Europe operates almost autonomously, the famous ITT technique of "business plans", even those originated in Brussels, still have to be ratified by ITT in the United States.

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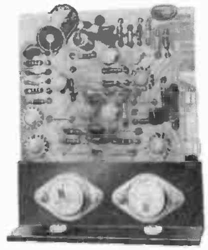

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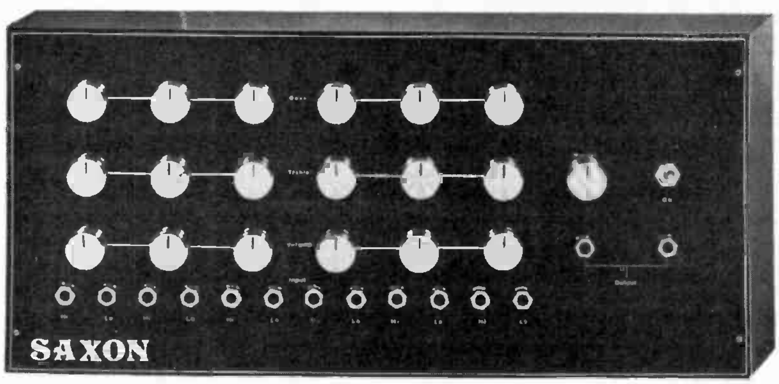

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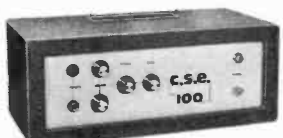

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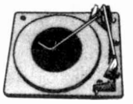

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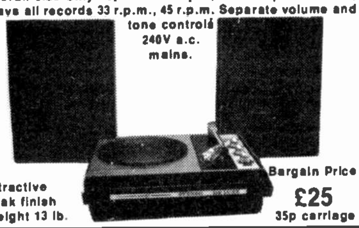

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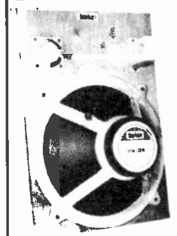
2/350V	14p	250/25V	14p	50 + 50/300V	50p
4/350V	14p	500/25V	20p	900/350V	95p
8/350V	22p	1000/25V	35p	32 + 32/250V	20p
16/350V	25p	1000/50V	47p	32 + 32/450V	60p
32/500V	50p	8 + 8/450V	22p	350 + 50/325V	85p
25/25V	10p	8 + 16/450V	25p	100 + 50 + 50/350V	85p
50/50V	10p	16 + 16/450V	40p	32 + 32 + 32/350V	65p
100/25V	10p	32 + 32/350V	40p	4700/63V	95p

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 17p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.

TRIMMERS 10pF, 30pF, 50pF, 5p. 100pF, 150pF, 15p.
CERAMIC, 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V–0·1 7p, 0·5 13p; 1mF 150V 15p; 2mF 150V 15p.
500V–0·001 to 0·05 5p; 0·1 10p; 0·25 13p; 0·47 25p.
MICRO SWITCH LEVER ACTION 20p.
SUB-MIN MICRO SWITCH 25p. Single pole change over.
TWIN GANG, "0-0" 208pF + 176pF £1·20; 500pF standard 75p.
365pF + 365pF with 25pF + 25pF, Slow motion drive 50p.
SHORT WAVE SINGLE. 10pF, 30p, 25pF, 55p, 50pF, 55p.
NEON PANEL INDICATORS 250V AC/DC. Amber 30p.
RESISTORS. ¼W, ½W, 1W, 20% 1p; 2W, 5p. 10Ω to 10M.
HIGH STABILITY. ½W 2% 10 ohms to 6 meg., 10p.
Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS 5 watt, 10 watt, 15 watt, 10 ohms to 100K 10p each.
TAPE OSCILLATOR COIL Valve type 35p.

NEW MODEL "BAKER LOUDSPEAKER", 12IN 50 WATT. GROUP 50/12. 8 OR 15 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. **£12·95**

BAKER MAJOR 12" £8·50



30–14,500 c/s, 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 20W. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit, 30–17,000 c/s with tweeter, crossover, baffle and instructions. **£10·95**

Please state 3 or 8 or 15 ohms.

BAKER "BIG-SOUND" SPEAKERS

'Group 25'	'Group 35'	'Group 50/12'
12in. 25W £7·75	12in. 35W £8·50	12in. 50W £12·95
3 or 8 or 15 ohm	3 or 8 or 15 ohm	8 or 15 ohm

TEAK VENEERED HI-FI SPEAKER AND CABINETS

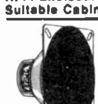
For 12in or 10in. dia. speaker	20 × 13 × 9in.	£10·50 Post 75p
For 13 × 8in or 8in speaker	18 × 10 × 9in.	£8·60 Post 45p
For 8 × 5in speaker	16 × 8 × 6in.	£5·00 Post 25p
For 6in and Tweeter	12 × 8 × 6in.	£4·00 Post 25p

LOUDSPEAKER CABINET WADDING 18in wide, 20p ft

GOODMANS 6½in. HI-FI WOOFER

4 ohm or 8 ohm. 10W. Large ceramic magnet. Special Cambric cone surround. Twin cone. Frequency response, 30–12,000 c/s. Ideal P.A. Columns. Hi-Fi Enclosure Systems, etc. **£4**
Suitable Cabinet 12x8x6 £4. Suitable Tweeter £2

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 c/s to 18,000 c/s. Size 3½x3½x2in deep. Rating 10W. 3 ohm.
Crossover £1·25 **£1·90** Post 20p

SPEAKER COVERING MATERIALS. Samples Large S.A.E.
Horn Tweeters 2-16kc/s, 10W 8 ohm or 15 ohm £2·25.
De Luxe Horn Tweeters 2-18kc/s, 15W, 15 ohm £4.
CROSSOVERS, TWO-WAY 3,000 c/s 3 or 8 or 15 ohm £1·25.
LOUDSPEAKERS P.M. 3 OHMS. 7x4in., £1·25; 6½in., £1·50; 8x5in., £1·60; 10in., £2·00; 8in., £1·75; 10x6in., £1·90.
SPECIAL OFFER: 80 ohm, 2¾in, 2½in, 35 ohm, 5in, 3in, 25 ohm. 2½in dia., 3in dia., 5in dia.
15 ohm, 3½in dia, 6x4in., 7x4in., 8x5in., **£1 each**
3 ohm, 2½in., 2½in., 3½in., 5in. dia. (6x4in 8 ohms £1·50).
RICHARD ALLAN TWIN CONE LOUDSPEAKERS,
8in. diameter 4W £2·50. 10in. diameter 5W £2·95;
12in. diameter 6W £3·50; 3/8/15 ohms, please state.
VALVE OUTPUT TRANS. 40p; MIKE TRANS. 50:1 40p.
Mike trans. mu metal 100:1 £1·25.

Loudspeaker Volume Control 15 ohms 10W with one inch long threaded bush for wood panel mounting. ¼in spindle. 65p each, Post 15p.

MAJOR 100 WATT ALL PURPOSE GROUP AMPLIFIER

All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. **£49** Carr. £1·00
NEW MODEL MAJOR—50 watt, 4 input, 2 vol. controls, treble and bass £39·95. Ideal disco amplifier.

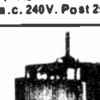
BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9V. **£4·50**
TWO CHANNEL STEREO VERSION **£5·95**
BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready Built, with volume. Treble and bass controls. 18 volt d.c. **£3·95**

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p. OUTLET BOXES, SURFACE 25p. FLUSH 60p. TWIN 85p. BALANCED TWIN RIBBON FEEDER 300 ohms. 7p yd. JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead-Socket 45p. Phono Plugs 5p. Phono Socket 5p. JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 12p. DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p. DIN SOCKETS lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p. VALVE HOLDERS, 5p; CERAMICS 10p; CANS 5p.

REVERSIBLE 4 POLE MOTOR

1,400 r.p.m. Reversible 42 Watt, spindle 1½"x3/16", size 3½"x3". As illustrated. With Cooling Fan. a.c. 240V. Post 25p **£2·20**

EMI TAPE MOTOR



EMI TAPE MOTORS. 120V or 240V a.c. 1,200 r.p.m. 4 pole 135mA. Spindle 0·187x 0·75in Size 3½ × 2½ × 2½in (illustrated). Post 25p. **£1·85**

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PHONOSONICS

SUPPLIERS OF QUALITY PRINTED CIRCUIT BOARDS, KITS AND COMPONENTS TO A WORLD-WIDE MARKET

SOUND-TO-LIGHT

The ever-popular P.E. AURORA—4 or 8 channels each responding to a different sound frequency and controlling its own light. Can be used with most audio systems and lamp intensities. A *must* for any Disco, and a fascinating visual display for the home.

4 channel component set (excl. thyristors)	£11·49
8 channel component set (excl. thyristors)	£20·32
Power supply component set	£4·78
PCB for 4 frequency channels	£2·50
PCB for power supply and 8 lamp drivers	£1·25

P.E. CCTV CAMERA
Details in List

VOICE OPERATED FADER

For automatically reducing music volume during "talk-over"—particularly useful for Disco work, or for home-movie shows.

Component set, incl. PCB	£2·95

P.E. GEMINI 30W STEREO AMPLIFIER

An exceptionally high quality Stereo Amplifier system, specifications for which are shown in detail in our list, together with semiconductor requirements. While stocks last.

Main Amplifier:	
Set of resistors, capacitors and presets	£5·96
Stereo printed circuit board	£1·28
Pre-Amplifier:	
Sets of resistors, capacitors, potentiometers and switches—	
Standard Tolerance Set	£10·57
Superior Tolerance Set	£16·04
Stereo PCB (as Published)	£2·20
Regulated Power Supply:	
Set of resistors, capacitors and preset	£4·58
Printed circuit board	72p

HI-FI TAPE LINK

Designed for use with reasonable quality tape decks, this high performance pre-amp includes record, playback and metering circuits.

Stereo component set (excl. panel meter)	£22·05
Mono component set (excl. panel meter)	£13·31
Power supply component set	£3·72
Stereo main PCB	£2·50
Stereo sub-assembly PCB	88p

TAPE-NOISE LIMITER

Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB)	£2·30
Regulated power supply (including printed circuit board)	£3·71

PROJECT Q4

Multi-system Quadraphonic Decoder

Decoder component set	£13·74
Power supply components	£3·22
Printed circuit board	£2·60

SEMICONDUCTOR TESTER

Essential test equipment for the enterprising home constructor.

Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and sub-assembly PCB (fuller details in list)	£6·06

PHASING UNIT

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl PCB)	£2·20

P.E. SOUND SYNTHESISER

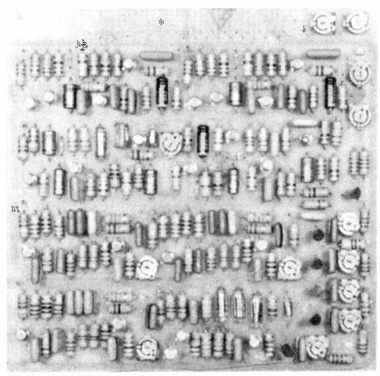
The well-acclaimed and highly versatile Synthesiser published in P.E. Feb 1973 to Feb. 1974

Component sets and printed circuit boards: Full details in list.

RHYTHM GENERATOR

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and snare drums, long and short brushes, blocks and cymbal), and with variable time signatures.

Tempo, Timing and Logic Circuit	
Component set (excl. switches)	£17·25
Double-sided PCB for above	£2·30
Mixer, Pre-amp and Effects Circuits	
Component set	£12·70
PCB (illustrated)	£2·67
Monitor Amplifier	
Component set and PCB	£3·10
Power Supply	
Component set and PCB	£5·65



All PCB's are printed on professional quality fibre-glass, are drilled and roller-tinned

ULTRASONIC TRANSMITTER-RECEIVER

A highly sensitive and long range "invisible beam detection circuit with numerous applications.

Component set with PCBs, but excluding transducers	£4·40

P.E. RONDO
PCB details in List.

POWER SLAVES
PCB details in List.

P.E. ELECTRONIC PIANO
Details in List.

HOME INTERCOM
Details in List.

SOUND BENDER

A multi-purpose sound controller, the functions of which include envelope shaper, tremolo, voice operated fader, automatic fader and frequency doubler

Component set	£5·83
Printed circuit board	£1·44

REVERBERATION UNIT

A high-quality unit having microphone and line input pre-amps, and providing full control over reverberation level

Component set (excl. spring unit)	£6·44
Printed circuit board	£1·40

P.E. MINISONIC
Details in List

8W AMPLIFIER

A moderately powered amplifier of more than average performance While stocks last

Main Amplifier	
Mono component set	£4·18
Stereo component set	£8·36
Mono printed circuit board	72p
Pre-Amplifier	
Mono component set	£2·50
Stereo component set	£6·46
Stereo PCB	£1·66
Power Supply	
Component set	£3·90

BIOLOGICAL AMPLIFIER

Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

Pre-Amplifier Module	
Component set and PCB	£3·48
Basic Output Circuits	
Combined component set with PCBs, for alphaphone, cardiophone, frequency meter and visual feed-back lamp driver circuits	£4·96
Audio Amplifier Module	
Type PC7	£5·50

PHOTOPRINT PROCESS CONTROL

For colour and B & W, an indispensible dark-room unit for finding exposure, controlling enlarger timing, and stabilising mains voltage.

Component set (excl meter)	£8·85
Printed circuit board	£1·60

ENLARGER EXPOSURE METER AND THERMOMETER

Dual-purpose dark-room unit with good accuracy

Component set with PCB, but excluding meter	£4·00

WIND AND RAIN UNIT

A manually controlled unit for producing the above-named sounds

Component set incl PCB	£2·40

PCB LAYOUT AND CIRCUIT DIAGRAMS SUPPLIED WITH ALL PCBs DESIGNED BY PHONOSONICS

P. & P.
Add 18p to all orders

VAT
Add 8% (or current rate if different) to total order cost including P. & P.

LIST
Send S.A.E. for free list giving fuller details of kits, PCBs, and other components.

OVERSEAS
P. & P. will be charged at cost. VAT does not currently apply. List gives fuller details including kit weights. Charge for list: Europe 10p, other countries 20p.

COLOUR CODE IDENTIFICATION SUPPLIED WITH MOST KITS AND AS PART OF LIST

Semiconductors

AC128	20p	MJE3055	75p	2N3823E	39p
AC176	20p	NKT0033	112p	2N4871	36p
BC107	13p	OC28	65p	2N5777	45p
BC108	13p	OC71	14p		
BC109	13p	OC84	25p	**Diodes**	
BC147	12p	ORP12	60p	1N914	4p
BC148	12p	ZTX107	12p	1N4001	6p
BC149	12p	ZTX503	15p	1N4002	7p
BC157	13p	ZTX531	23p	1N4004	8p
BC158	13p	2N706	13p	1N4005	8p
BC159	13p	2N914	22p	1OD6	8p
BC182L	12p	2N1304	22p	BA145	23p
BC204	14p	2N2219	27p	OA91	7p
BC209c	14p	2N2905	27p	OA200	8p
BC212L	15p	2N2907	22p	1GP7	12p
BC478	29p	2N3054	66p	1SJ50	11p
BCY71	22p	2N3055	50p	ZIL	68p
BFY50	22p	2N3702	12p		
BFY52	24p	2N3703	12p		
BSY95A	22p	2N3704	12p		
MJE2955	110p	2N3819	35p		

Integrated Circuits

709 TO5 or DIL	40p
723 TO5	95p
741 8-pin DIL	40p
747 14-pin DIL	115p
748 TO5	63p
748 8-pin DIL	63p
748 14-pin DIL	63p
7400	20p
7402	20p
7420	20p
7447	175p
7473	44p
7489	575p
µA7815 TO220	250p
CA3046	69p
MFC6040	95p
PA263	169p
SG3402N	169p
Minitron 3015F	225p

Zeners

3·3V 400mW	12p
4 7V 1W	25p
5·6V 1·3W	20p
6·2V 400mW	15p
9 1V 400mW	15p
11V 1W	20p
12V 400mW	15p
12V 1 3W	20p
18V 400mW	15p
16V 1W	20p
20V 400mW	15p
20V 1 3W	23p
27V 400mW	15p

Thyristors

1A 400V	75p

Electrolytic Capacitors (µF/V)

0·47/63V	8p	47/63	7p	470/40	20p
1 0/63V	6p	50/6 4	6p	500/64	46p
1·5/63V	6p	100/10	6p	680/6 3	10p
2·2/63V	6p	100/25	6p	680 25	20p
4·7/63	6p	100/40	7p	680/40	25p
6 8/40	6p	100/63	13p	1000/10	14p
10/25	6p	150/16	6p	1000/16	25p
10/63	6p	150/63	13p	1000/25	30p
15/40	6p	220/10	6p	1000/40	54p
22/10	6p	220/16	7p	2200/25	45p
22/25	6p	220/25	11p	2200/40	63p
33 6 3	6p	220/40	14p	2800/100	360p
33/16	6p	220/63	21p	3300/63	133p
33/40	6p	330/10	6p	3300/100	350p
33/50	6p	470/6 3	6p	4700/16	60p
47/25	6p	470/10	10p	4700/25	75p
47/40	6p	470/25	16p	4700/40	93p

Polyester (µF)

0 01	3p
0·015	3p
0·022	3p
0·033	3½p
0·047	3½p
0 068	3½p
0 1	4p
0 15	5p
0 22	5p
0 33	7p
0 47	9p
0 68	11p
1 0	14p
2 2	24p

Tantalum (µF/V)

0·1/35	12p
0·22/35	12p
0·47/35	12p
1 0/35	12p
1 5/35	16p
2 2/35	12p
4 7/35	12p
10/16	12p
10/25	16p
15/6·3	16p
22/16	16p
47/6 3	16p
47/16V	25p
100/3	16p

PRICES ARE CORRECT AT TIME OF PRESS. E. & O.E. DELIVERIES SUBJECT TO AVAILABILITY.

PHONOSONICS, DEPT. PE32, 25 KENTISH ROAD, BELVEDERE, KENT DA17 5BW

MAIL ORDER ONLY

(P.S. DON'T FORGET VAT!)

TRANSISTORS

						TIP41A	68p	2N2905	18p	**FETS**	
						TIP42A	86p	2N2926RB	8p	BF244	36p
						ZTX300	14p	2N29260	8p	MPF102	31p
						ZTX304	24p	2N2926YG	9p	MPF103	31p
AC126 7	11p	BC177	18p	BFR41	26p	ZTX500	15p	2N3053	18p	MPF104	31p
AC128	11p	BC178	17p	BFX29	30p	ZTX504	50p	2N3055	40p	MPF105	31p
AC176	11p	BC179	18p	BFX30	30p	2N696	15p	2N3442	140p	2N3819	20p
AC187	12p	BC182	10p	BFY50	15p	2N697	13p	2N3702/3	11p	2N3820	57p
AC188	11p	BC183	10p	BFY51	15p	2N698	30p	2N3704/5	11p	2N3823	60p
AD149	43p	BC184	11p	BFY52	15p	2N706	12p	2N3706/7	11p	2N5457	31p
AD161	37p	BC212	11p	BRY39	34p	2N708	18p	2N3708/9	9p	2N5458	31p
AD162	37p	BC213	10p	MJE2955	95p	2N930	18p	2N3772	181p	2N5459	31p
AF114 5	13p	BC214	13p	MJE3055	65p	2N1131/2	18p	2N3773	240p		
AF116 7	13p	BD115	55p	OC26	40p	2N1302/3	17p	2N3903/4	15p	**MOSFETS**	
AF139	41p	BD124	75p	OC28	55p	2N1304/5	21p	2N4058	15p	40603	58p
AF239	44p	BD131	42p	OC35	48p	2N1306/7	28p	2N4060	13p	40673	80p
BC107 8	9p	BD132	45p	OC36	52p	2N1308/9	28p	2N5191	95p	40841	75p
BC109	10p	BF115	22p	OC41/2	15p	2N1613	20p	2N5194	85p	3N128	90p
BC147 8	7p	BF167	23p	OC44/5	11p	2N1711	20p			3N140	85p
BC149	9p	BF173	25p	OC70/1/2	11p	2N2219	20p	**UJTS**		3N141	75p
BC157	13p	BF184	22p	OC73	60p	2N2221	20p	TIS43	26p		
BC158	12p	BF194	11p	OC81/2	12p	2N2222	20p	2N2160	70p		
BC159	14p	BFR39	28p	OC83/4	28p	2N2369	14p	2N2646	34p		
BC169C	12p	BFR40	28p	TIP2955	70p	2N2484	30p	2N4671	31p		

SPECIAL OFFERS

555	50p	CA3046	55p
741	25p	ML723	55p
MC1310	245p	SN7447	95p
MC1312	220p	SN7490	52p

OPTO-ELECTRONICS

Photo-Transistors		Light Dependent Resistors	
OCP70	50p	ORP12	50p
OCP71	65p	ORP60	55p
2N5777	60p	ORP61	55p

LEDs TIL209 16p
Red 16p Green 35p Yellow 35p
MINITRON 3015F 120p

LATEST ICs—
MANY APPLICATIONS
ICL8038 Voltage Controlled Oscillator 290p
NE567 Tone Decoder 250p
(Application Data 10p)

RECTIFIER DIODES

500mA	
BY100	15p
1 Amp	
BY126	12p
BY127	12p
1N4001	5p
1N4004	6p
1N4007	7p
1·5 Amp	
PL4004	10p
3 Amp	
PL7004	20p
6 Amp	
BYZ10	50p
BYZ11	50p
BYZ12	50p
BYZ13	50p

SIGNAL DIODES

BA100	10p
OA47	7p
OA70	8p
OA79	7p
OA81	7p
OA85	9p
OA90	6p
OA91	6p
OA95	7p
OA200	6p
OA202	7p
1N914	4p
1N916	6p
1N4148	4p

ZENER DIODES
3·3V to 33V

400MW	9p
1·3W	18p
1·5W	25p
10W	55p

Other Diodes
TUNNEL
AEY11 50p

VARICAP

BB103	15
BB104	30p
BB105	30p

BRIDGE RECTIFIERS

	50V	100V	400V	600V
250mA	16p	—	—	—
1 Amp	20p	21p	24p	25p
2 Amp	30p	35p	45p	48p
4 Amp	47p	48p	80p	70p
6 Amp	55p	60p	78p	98p

SCR—THYRISTORS

	50V	100V	400V	600V
1 Amp	42p	48p	60p	78p
3 Amp	43p	49p	78p	100p
7 Amp	—	80p	84p	115p
16 Amp	—	82p	98p	—

Other
C106D 45p, 2N3525 91p, 2N4444 185p

TRIACS

	100V	400V	500V
3 Amp	85p	99p	120p
6 Amp	88p	120p	150p
10 Amp	109p	154p	165p
16 Amp	145p	180p	200p

Other
40430 90p, 40486 85p, 40669 95p.
DIAC S12 for use with above triacs 21p.

VOLTAGE REGULATORS
ML723 55p MFC4060 70p
1 Amp

		Plastic (TO220)	(TO3)
7805	5V	140p	175p
7812	12V	140p	—
7815	15V	140p	—
7818	18V	140p	—
7824	24V	140p	—

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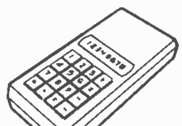

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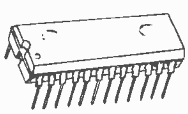

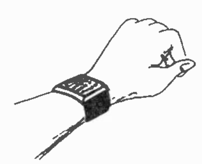

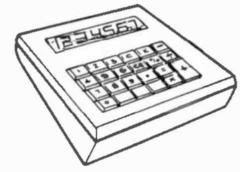

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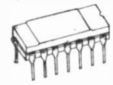

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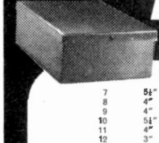

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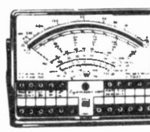

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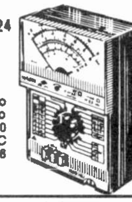

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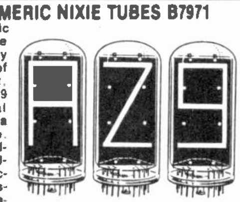

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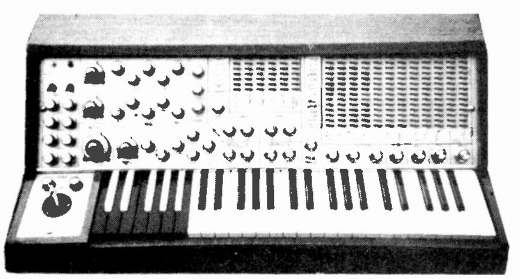

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154	500	19	8	14·0 × 13·4 × 11·8	12·41	91
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64	75	2	4	7·0 × 6·7 × 6·1	0-115-210-240	2·64	38
4	150	3	4	8·9 × 7·7 × 7·7	0-115-200-220-240	3·75	45
66	300	6	4	9·9 × 9·6 × 8·6	,, ,,	5·29	53
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213	1·0	0·5	1	4	6·1 × 5·8 × 4·8	0-12V at 0·5A × 2	1·58	30
71	2	1	1	12	7·0 × 6·4 × 6·1	0-12V at 1A × 2	2·09	38
18	4	2	2	12	8·3 × 7·7 × 7·0	0-12V at 2A × 2	2·60	38
70	6	3	3	8	8·9 × 8·0 × 7·7	0-12V at 3A × 2	3·75	45
108	8	4	5	8	9·9 × 8·9 × 8·6	0-12V at 4A × 2	4·15	45
72	10	5	6	4	9·9 × 9·6 × 8·6	0-12V at 5A × 2	4·67	53
116	12	6	6	12	9·9 × 10·2 × 8·6	0-12V at 5A × 2	5·02	53
17	16	8	8	12	12·1 × 9·9 × 10·2	0-12V at 8A × 2	6·62	60
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79	1·0	2	4	7·0 × 6·7 × 6·1	,, ,,	2·18	38
3	2·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·18	38
20	3·0	4	8	9·9 × 8·3 × 8·6	,, ,,	4·12	45
21	4·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·67	53
51	5·0	6	12	12·1 × 8·6 × 10·2	,, ,,	5·83	53
117	6·0	8	0	12·1 × 9·3 × 10·2	,, ,,	6·51	60
88	8·0	12	0	12·1 × 11·8 × 10·2	,, ,,	9·00	67
89	10·0	13	12	14·0 × 10·2 × 11·8	,, ,,	8·97	73

50 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
102	0·5	1	12	7·0 × 6·4 × 6·1	0-19-25-33-40-50V	2·35	30
103	1·0	2	12	8·3 × 7·4 × 7·0	,, ,,	3·08	38
104	2·0	5	8	7·9 × 8·9 × 8·6	,, ,,	4·26	45
105	3·0	6	12	9·9 × 10·2 × 8·6	,, ,,	5·28	53
106	4·0	10	0	12·1 × 10·5 × 10·2	,, ,,	6·91	67
107	6·0	12	0	14·0 × 10·2 × 11·8	,, ,,	11·00	67
118	8·0	18	0	14·0 × 12·7 × 11·8	,, ,,	11·80	85
119	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	15·45	*

60 VOLT RANGE

Ref. No.	Amps.	Weight lb	oz	Size cm.	Secondary Taps	P & P £	p
124	0·5	2	4	7·0 × 6·7 × 6·1	0-24-30-40-48-60V	2·12	38
126	1·0	3	4	8·9 × 7·7 × 7·7	,, ,,	3·10	38
127	2·0	6	4	9·9 × 9·6 × 8·6	,, ,,	4·62	45
125	3·0	8	12	12·1 × 9·9 × 10·2	,, ,,	6·84	60
123	4·0	13	12	12·1 × 11·8 × 10·2	,, ,,	7·96	67
40	5·0	12	00	14·0 × 10·2 × 11·8	,, ,,	8·87	73
120	6·0	15	8	14·0 × 12·1 × 11·8	,, ,,	10·27	85
121	8·0	25	00	14·0 × 14·7 × 11·8	,, ,,	13·64	*
122	10·0	25	0	17·2 × 12·7 × 14·0	,, ,,	15·93	*
189	12·0	29	00	17·2 × 14·0 × 14·0	,, ,,	18·16	*

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Ref. No.	mA	Weight lb	oz	Size cm.	Volts	P & P £	p
238	200		2	2·8 × 2·6 × 2·0	3-0-3	1·40	10
212	1A, 1A	1	4	6·1 × 5·8 × 4·8	0-6, 0-6	1·67	30
13	100		4	3·9 × 2·6 × 2·9	9-0-9	1·28	13
235	330, 330		4	4·8 × 2·9 × 3·5	0-9, 0-9	1·42	19
207	500, 500	1	00	6·1 × 5·4 × 4·8	0-8-9, 0-8-9	1·75	30
208	1A, 1A	1	12	7·0 × 6·4 × 6·1	0-8-9, 0-8-9	3·00	38
236	200,200		4	4·8 × 2·9 × 3·5	0-15, 0-15	1·30	19
214	300, 300	1	4	6·1 × 5·8 × 4·8	0-20, 0-20	1·76	30
221	700 (d.c.)	1	8	7·0 × 6·1 × 6·1	20-12-0-12-20	1·98	38
206	1A, 1A	2	12	8·3 × 7·7 × 7·0	0-15-20, 0-15-20	3·15	38
203	500,500	2	4	8·3 × 7·0 × 7·0	0-15-27, 0-15-27	2·73	38
204	1A, 1A	3	4	8·9 × 7·7 × 7·7	0-15-27, 0-15-27	3·50	38

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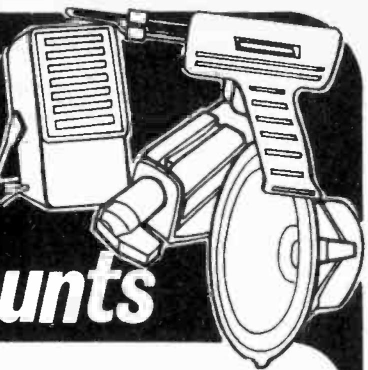

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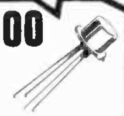

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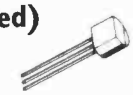

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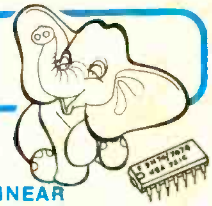

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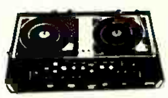

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